PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re the Application of:

LIN et al.

Serial No.: 09/922,459

Filed: 08/03/2001

Atty. Docket No.: 3123-373

For: "METHOD AND APPARATUS FOR PROVIDING AN EARLY WARNING OF THERMAL DECAY IN MAGNETIC STORAGE DEVICES"

Group Art Unit: 2627

Examiner: Rodriguez, Glenda P.

APPEAL BRIEF

CERTIFICATE OF MAILING

I HEREBY CERTIFY THAT THIS CORRESPONDENCE IS BEING DEPOSITED WITH THE UNITED STATES POSTAL SERVICE AS FIRST CLASS MAIL IN AN ENVELOPE ADDRESSED TO: MAIL STOP APPEAL BRIEF - PATENTS, COMMISSIONER FOR PATENTS, P.O. BOX 1450, ALEXANDRIA, VA 22313-1450, ON THIS 6th DAY OF December 2006.

Debbie K. Keller

Debbie K. Keller

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Applicants hereby appeal to the Board of Patent Appeals and Interferences from the last decision of the Examiner.

The fee for this Appeal Brief is $500.00, as set forth in 37 CFR 41.20(b)(2). The Commissioner is hereby authorized to charge the credit card identified on Form PTO-2038 in the amount of $500.00 for the fee associated with filing this Appeal Brief.

A request for a two-month extension of time accompanies this Appeal Brief. The Commissioner is hereby authorized to charge the credit card identified on Form PTO-2038 in the amount of $450.00 for the two-month extension fee.

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Although Applicants believe that no other fees are due, the Commissioner is hereby authorized to charge Deposit Account No. 50-2198 for any fee deficiencies associated with filing this paper.

The index of subject matter is as follows:

I. Real Party In Interest

The real party in interest in this appeal is Seagate Technology LLC, which acquired the prior assignee Maxtor Corporation on May 19, 2006.

II. Related Appeals And Interferences

There are no appeals or interferences that will directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

III. Status Of Claimed Subject Matter

1. Total Number Of Claims In Application

Claims in the application are: 1-100

2. Status Of All Claims

Claims canceled:	None
Claims withdrawn:	None
Claims pending:	1-100
Claims allowed:	None[1]
Claims objected to:	None[2]
Claims rejected:	1-100

[1] The Examiner allowed Claims 21-35, 56-60 and 96-100 in Section 8. However, the Examiner rejected Claims 1-100 in Section 2. Therefore, Applicants will treat Claims 21-35, 56-60 and 96-100 as rejected.

[2] The Examiner objected to Claims 5, 13, 44-46, 53-55, 64, 69, 74 and 78-80 in Section 7. However, the Examiner rejected Claims 1-100 in Section 2. Therefore, Applicants will treat Claims 5, 13, 44-46, 53-55, 64, 69, 74 and 78-80 as rejected.

3. Claims On Appeal

Claims on appeal are: 1-100

IV. Status Of Amendments

No amendments have been filed after the outstanding Office Action dated July 13, 2006.

V. Summary Of Claimed Subject Matter

The specification illustrates independent Claims 1, 11, 21, 30, 36, 47, 56, 61, 66, 71, 76, 81, 86, 91 and 96 as described below.

The claimed subject matter is directed to the early detection of thermal decay in magnetic storage devices. (Specification, page 1, lines 9-11).

Disk drive 100 includes base 104, magnetic disk 108, transducer head 124, voice coil motor 128, controller 136 and channel 140. (Specification, page 9, lines 4-21 and Fig. 1).

Magnetic disk 108 includes magnetic material. (Specification, page 1, lines 13-15 and page 9, lines 8-9). Magnetic disk 108 also includes data tracks 132 divided into data sectors 204a-h and servo sectors 208a-h. (Specification, page 10, lines 1-3 and Fig. 2). Magnetic disk 108 also includes zones 212a-c. (Specification, page 10, lines 15-16 and Fig. 2). User data may be stored in data tracks 132 in zone 212a located towards an outside diameter of disk 108 at a relatively high frequency, however user data generally cannot be written to a data track 132 within zone 212c located towards an inner diameter of disk 108 at the same high frequency as user data in a data track 132 in zone 212a. (Specification, page 10, line 17 to page 11, line 2 and Fig. 2).

Transducer head 124 reads and writes information to and from data tracks 132. (Specification, page 1, lines 18-19 and page 9, line 14). Voice coil motor 128 moves transducer head 124 radially relative to data tracks 132. (Specification, page 9, lines 14-19). Controller 136 operates voice coil motor 128. (Specification, page 9, lines 19-20). Channel 140 processes information read from magnetic disk 108 by transducer head 124. (Specification, page 9, lines 20-21).

A bit cell is defined as the shortest length of data track 132 that can encode a bit of user data, and corresponds to the minimum length of data track 132 used to store a magnetic transition. (Specification, page 11, lines 18-20). Bit cells 300 occupy a portion of data track 132 in a longitudinal recording scheme. (Specification, page 11, lines 15-18). Bit cells 400 occupy a portion of data track 132 in a perpendicular recording scheme. (Specification, page 13, lines 5-11).

In a first flow chart, a test pattern that is more susceptible to thermal decay than normal user data is written to magnetic disk 108 (step 500), the test pattern is read from magnetic disk 108 (step 504) to obtain and store a reference amplitude (step 508), a determination is made whether disk drive 100 should be tested for thermal decay (step 512), and if so, the test pattern is read from magnetic disk 108 to obtain an observed amplitude (step 516), a determination is made whether the reference amplitude is greater than the observed amplitude plus a marginal amount (step 520), and if so, a thermal decay warning signal is generated (step 524). (Specification, page 15, line 13 to page 19, line 1 and Fig. 5).

In a second flow chart, automatic gain control (AGC) fields are read from magnetic disk 108 (step 600), a test pattern is written to magnetic disk 108 at an AGC field that is more susceptible to thermal decay than other AGC fields (step 604), the test pattern is read from

magnetic disk 108 (step 608) to obtain and store a reference amplitude (step 612), a determination is made whether disk drive 100 should be tested for thermal decay (step 616), and if so, the test pattern is read from magnetic disk 108 to obtain an observed amplitude (step 620), a determination is made whether the reference amplitude is greater than the observed amplitude plus a marginal amount (step 624), and if so, a thermal decay warning signal is generated (step 628). (Specification, page 19, line 8 to page 20, line 14 and Fig. 6).

In an embodiment that illustrates Claim 1, the test pattern written to data track 132 of magnetic disk 108 in step 500 has higher data density than user data in data track 132. (Specification, page 5, lines 7-11 and page 15, lines 18-21).

In an embodiment that illustrates Claim 11, the test pattern written to data track 132 of magnetic disk 108 in step 500 has lower data density than user data in data track 132. (Specification, page 5, lines 18-21 and page 16, lines 13-18).

In an embodiment that illustrates Claim 21, a sector of magnetic disk 108 that is particularly susceptible to thermal decay is identified in step 600, and the test pattern is written to the sector. (Specification, page 6, lines 9-16, page 10, lines 9-13 and page 19, lines 8-14).

In an embodiment that illustrates Claim 30, the test pattern written to data track 132 of magnetic disk 108 in step 500 is more susceptible to thermal decay than a 1T pattern. (Specification, page 15, lines 17-18).

In an embodiment that illustrates Claim 36, the test pattern written to data track 132 of magnetic disk 108 in step 500 is more susceptible to thermal decay than user data in data track 132. (Specification, page 5, lines 5-11 and page 15, lines 15-16).

In an embodiment that illustrates Claim 47, the test pattern written to data track 132 of magnetic disk 108 in step 500 has different data density than user data in data track 132, and data

track 132 has reduced magnetization capacity. (Specification, page 5, lines 7-11 and 18-21, page 7, lines 5-7, page 15, lines 13-21 and page 21, lines 15-17).

In an embodiment that illustrates Claim 56, the test pattern written to data track 132 of magnetic disk 108 in step 500 is more susceptible to thermal decay than a 1T pattern, and data track 132 has reduced magnetization capacity. (Specification, page 7, lines 5-7, page 15, lines 17-18 and page 21, lines 15-17).

In an embodiment that illustrates Claim 61, the test pattern written to data track 132 of magnetic disk 108 in step 500 has different data density than user data in data track 132. (Specification, page 5, lines 7-11 and 18-21 and page 15, lines 13-21).

In an embodiment that illustrates Claim 66, the test pattern written to data track 132 of magnetic disk 108 in step 500 has larger data density than user data in data track 132. (Specification, page 5, lines 7-11 and page 15, lines 18-21).

In an embodiment that illustrates Claim 71, the test pattern written to data track 132 of magnetic disk 108 in step 500 has smaller data density than user data in data track 132. (Specification, page 5, lines 18-21 and page 16, lines 13-18).

In an embodiment that illustrates Claim 76, the test pattern written to data track 132 of magnetic disk 108 in step 500 has different data density than a 1T pattern on data track 132. (Specification, page 15, lines 17-21 and page 16, lines 10-13).

In an embodiment that illustrates Claim 81, a sector of magnetic disk 108 that is particularly susceptible to thermal decay is identified in step 600, and the test pattern is written to the sector in response to identifying the sector. (Specification, page 6, lines 9-16, page 10, lines 9-13 and page 19, lines 8-14).

In an embodiment that illustrates Claim 86, a sector of magnetic disk 108 that is particularly susceptible to thermal decay is identified in step 600, and the test pattern that is written to the sector in response to identifying the sector is more susceptible to thermal decay than any servo information and any user data on magnetic disk 108. (Specification, page 5, lines 5-11, page 6, lines 9-16, page 7, lines 5-7, page 10, lines 9-13, page 15, lines 15-16, page 19, lines 8-14 and page 21, lines 15-17 and provisional,[3] page 1, lines 27-28).

In an embodiment that illustrates Claim 91, a sector of magnetic disk 108 that is particularly susceptible to thermal decay is identified in step 600, the test pattern is written to the sector in response to identifying the sector in step 604 and the reference amplitude is stored in step 608, then disk drive 100 is shipped from a factory to an end user, and then the test pattern is read from the sector in step 620. (Specification, page 6, lines 9-16, page 10, lines 9-13 and page 19, line 8 to page 20, line 9 and provisional, page 1, lines 19 and 39-40).

In an embodiment that illustrates Claim 96, the test pattern written to data track 132 of magnetic disk 108 in step 500 is an evaluation test pattern that exhibits the greatest amount of thermal decay. (Specification, page 6, lines 5-8 and page 17, lines 7-12).

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[3] The application claims priority from U.S. Provisional Application Serial No. 60/223,444 filed on August 4, 2000 (hereinafter the "provisional"). The application also incorporates the provisional by reference in its entirety. (Specification, page 1, lines 4-7).

The M.P.E.P. discusses incorporation by reference as follows: "The information incorporated is as much a part of the application as filed as if the text was repeated in the application, and should be treated as part of the text of the application as filed." (M.P.E.P. § 2163.07(b), Rev. 4, October 2005, page 2100-192).

Therefore, the application includes the provisional and the claim illustrations may refer to the provisional. The provisional is reproduced with inserted page and line numbers in the evidence appendix.

VI. Grounds Of Rejection To Be Reviewed On Appeal

The issues on appeal are (1) whether Claims 1-100 should be rejected under 35 U.S.C. § 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention, (2) whether Claims 1, 4, 6-11, 14-20, 37-40, 43, 47-52, 61-63, 66-68, 71-73, 76, 77, 81, 82, 86, 87, 91 and 92 (and apparently 36) should be rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,429,984 to Alex (hereinafter "Alex")[4] in view of U.S. Patent No. 6,633,442 to Quak et al. (hereinafter "Quak"), (3) whether Claims 3, 41, 42, 65, 70 and 75 should be rejected under 35 U.S.C. § 103(a) as being unpatentable over Alex and Quak and further in view of U.S. Patent No. 6,091,559 to Emo et al. (hereinafter "Emo"), (4) whether Claims 83, 88 and 93 should be rejected under 35 U.S.C. § 103(a) as being unpatentable over Alex and Quak and further in view of U.S. Patent No. 6,445,525 to Young (hereinafter "Young"), and (5) whether Claims 84, 85, 89, 90, 94 and 95 should be rejected under 35 U.S.C. § 103(a) as being unpatentable over Alex and Quak and further in view of U.S. Patent No. 6,347,016 to Ishida et al. (hereinafter "Ishida").

[4] The Examiner refers to Alex as Sacks et al. at page 7, line 4. Applicants believe that the reference to Sacks et al. is a typographical error – as Applicants have mentioned in the previous four Replys.

VII. Argument

1. Claim Rejections Under 35 U.S.C. § 112, First Paragraph

The Examiner rejected Claims 1-100 under 35 U.S.C. § 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

The Examiner asserts that "the provisional Application is silent in mentioning and/or describing how to make and use the entire procedure claimed . . . Applicant should note that the provisional application is merely a bunch or desired results/procedures/effects and lacks any positive enablement therein, such as found in applicants specification and figures 5 and 6."

The M.P.E.P. discusses the enablement requirement as follows:

> The enablement requirement refers to the requirement of 35 U.S.C. 112, first paragraph that the specification describe how to make and how to use the invention. (M.P.E.P. § 2164, Rev. 4, October 2005, page 2100-192).
>
> Any analysis of whether a particular claim is supported by the disclosure in an application requires a determination of whether that disclosure, when filed, contained sufficient information regarding the subject matter of the claims as to enable one skilled in the pertinent art to make and use the claimed invention. (M.P.E.P. § 2164.01, Rev. 4, October 2005, page 2100-193).
>
> Whether the specification would have been enabling as of the filing date involves consideration of the nature of the invention, the state of the prior art, and the level of skill in the art. (M.P.E.P. § 2164.05(a), Rev. 4, October 2005, page 2100-199).
>
> In order to make a rejection, the examiner has the initial burden to establish a reasonable basis to question the enablement provided for the claimed invention. (M.P.E.P. § 2164.04, Rev. 4, October 2005, page 2100-197).

The specification must provide an enabling disclosure for the claims. However, the provisional is not covered by the enablement requirement.

The Examiner has failed to indicate that the claims are unsupported by the specification. Instead, the Examiner asserts that the claims are unsupported by the provisional, and <u>admits</u> that the claims are supported by the specification.

The Examiner also asserts that "Applicant's arguments filed 4/26/06 have been fully considered but they are not persuasive. Hence Claims 1-100 remain rejected under 112 first paragraph in view of the lack of enablement as cited above." However, in the Office Action dated April 4, 2006, the Examiner asserted that "the Provisional application 60/223444 is clearly inadequate to support the claimed invention. Hence, the applicant is not entitled to the earlier filing date and therefore, the argued references are adequate Prior Art." Likewise, in the Reply dated April 26, 2006, Applicants argued that "The denial of domestic priority is flawed." Thus, Claims 1-100 were not previously rejected under section 112, first paragraph. Instead, Claims 1-100 were previously denied domestic priority to the provisional.

The Examiner has confused domestic priority (which involves the provisional) with the enablement requirement (which does not involve the provisional).

Applicants need not address the Examiner's disparaging and inaccurate remarks about the provisional in this rejection since the provisional is irrelevant to the enablement requirement. Applicants shall address the denial of domestic priority in the art rejections.

The Examiner has the burden of presenting by a preponderance of evidence why a person skilled in the art would not recognize that the specification provides an enabling disclosure for the claims. However, the Examiner has <u>not even attempted</u> to provide an explanation. Instead, the Examiner merely asserts that "the provisional Application is silent in mentioning and/or

describing how to make and use the entire procedure claimed." Thus, the Examiner has no explanation whatsoever. Since the Examiner has failed to meet (over even attempt to meet) this burden, for this reason alone, the rejection under section 112, first paragraph is improper. Moreover, the rejection has no merit since, as the Examiner admits, the specification provides an enabling disclosure.

2. Claim Rejections Under 35 U.S.C. § 103(a) – Alex and Quak

The Examiner rejected Claims 1, 4, 6-11, 14-20, 37-40, 43, 47-52, 61-63, 66-68, 71-73, 76, 77, 81, 82, 86, 87, 91 and 92 (and apparently 36) under 35 U.S.C. § 103(a) as being unpatentable over Alex in view Quak.

Alex

Alex discloses a disk drive that refreshes data stored on a disk that undergoes thermal degradation. The data is stored at an areal density that is sufficiently high to cause spontaneous thermal degradation of the data over time. Thereafter, the data is read from the disk and then re-written to the disk (refreshed) while the readback signal amplitude loss is sufficiently small to lead to a small number of errors (soft errors) that can be corrected by error correction code, and before the readback signal amplitude loss is sufficiently large to lead to a large number of errors (hard errors) that cause permanent data loss. Repeated refresh operations allow the data to be stored for an indefinite period of time at an areal density sufficiently high to cause thermal degradation prior to each refresh operation while avoiding hard errors. As a result, there is no need to scan the entire disk to refresh weak data such as with the Data Lifeguard feature in Western Digital disk drives.

Alex discloses providing a refresh indicator that causes the refresh operation to occur in response to a predetermined event. For instance, the refresh indicator can cause the refresh operation to occur (1) when the readback signal amplitude falls below a predetermined fraction (such as half) of its initial value when the data was written, (2) when the readback signal amplitude falls below a predetermined fraction of a second amplitude of a test signal that has just been written, (3) at a predetermined time interval (the next refresh date), (4) at random time intervals within a predetermined range, or (5) in response to a soft error.

Alex discloses characterizing the degradation in readback signal amplitude as a function of time in Fig. 1. Graphs 3, 4 and 5 have linear densities of 400, 300 and 200 kFCI (thousands of flux changes per inch) at corresponding frequencies of 100, 75 and 50 MHz. Graphs 3, 4 and 5 are generated by writing the magnetic transitions closer together either by recording at higher frequencies than normal or by spinning the disk slower than normal.

Alex discloses selecting the refresh indicator based on the graphs in Fig. 1. That is, the refresh indicator is related to the rate of loss of the readback signal amplitude, which in turn depends on the areal density of the data being recorded. For instance, the refresh operation occurs when the readback signal amplitude (Sd) at the time of reading the data falls to a predetermined fraction of the readback signal amplitude (Si) at the time of writing the data as shown in Fig. 2. As another example, the refresh operation occurs automatically at a predetermined time duration (t3–t1) when the data is written with a readback signal amplitude (Si) at an initial time (t1) and the data is expected to have a readback signal amplitude (Sd) at a later time (t3) as shown in Fig. 2.

Alex discloses test circuit 80 in Fig. 10 for obtaining the graphs in Fig. 1. Test circuit 80 includes read-write analyzer 81, spectrum analyzer 82, oscilloscope 83, spinstand 84 and personal computer 85. Disk 12 is mounted on spinstand 84, head 43 reads from and writes to disk 12, and read-write analyzer 81 supplies a signal to and receives a readback signal from head 43. A user manually detects changes in the frequency and time domains of the readback signal using spectrum analyzer 82 and oscilloscope 83. Personal computer 85 enables the user to control the location on disk 12 where the data is written, the amplitude of the read and write signals, the frequency of the write signal, the recording density, the radius of the track being tested, the revolutions per minute (rpm) of disk 12, whether or not the track was erased prior to writing the signal of interest and whether the readback signal of the track was electronically filtered during reading.

Quak

Quak discloses setting bit density and track density in a disk drive. The initial bit density and the initial track density is determined for each head in the disk drive, thereby providing the initial total capacity for the disk drive. The initial total capacity for the disk drive is compared to a desired capacity for the disk drive. If the initial total capacity is greater than the desired capacity, then a bit density or a track density is reduced to provide an adjusted total capacity for the disk drive that has less excess capacity over the desired capacity than the initial total capacity has over the desired capacity. If the initial total capacity is less than the desired capacity, then a bit density or a track density is increased to provide an adjusted total capacity for the disk drive that reaches or exceeds the desired capacity.

Quak discloses determining the initial bit density for each head by writing test tracks with the head using different bit densities, reading the test tracks with the head, determining the highest bit density that provides an acceptable number of errors and selecting a bit density that is less than the highest bit density to provide a safety margin.

Quak discloses determining the initial track density for each head by measuring the actual width of the read and write elements on the head or by writing test tracks with the head and measuring the width of the test tracks.

Alex and Quak

Alex in view of Quak might suggest that a user manually writes a first test signal to a disk using a head and then reads the first test signal from the disk using the head and detects changes in the frequency and time domains of the readback signal using a spectrum analyzer and an oscilloscope to develop graphs of readback signal amplitude degradation as a function of time for various frequencies as described in Alex, then providing a disk drive that adjusts the bit density and track density for the head and the disk so that the disk drive has an adjusted total capacity that is closer to the desired capacity as described in Quak, and then writing data to the disk using the head, reading the data from the disk using the head and then refreshing the data on the disk using the head and a refresh indicator based on the graphs as described in Alex.

Alex in view of Quak fails to teach or suggest performing the refresh operation on a test pattern. Instead, the refresh operation is performed on user data. Alex in view of Quak also fails to teach or suggest performing the refresh operation on a test pattern on a track that has higher, lower or different data density than user data on the track, much less different data density than a 1T pattern on the track. Alex in view of Quak also fails to teach or suggest performing the

refresh operation on a test pattern on a track that has greater susceptibility to thermal decay than user data on the track, much less any servo information and any user data on the disk. Alex in view of Quak also fails to teach or suggest performing the refresh operation on a track that has reduced magnetization capacity relative to other tracks, much less identifying a sector on the disk that has greater than average susceptibility to thermal decay and performing the refresh operation on the sector in response to identifying the sector. Alex in view of Quak also fails to teach or suggest writing the data to the disk, then shipping the disk drive from a factory to an end user, and then performing the refresh operation on the data.

Claim 61 (Group I)

Claim 61 recites "A method for providing an early warning of thermal decay in a disk drive, wherein . . . a test pattern on the track has a different data density than user data on the track . . . comprising: reading the test pattern from the track to obtain an observed amplitude; comparing the reference amplitude to the observed amplitude; and producing a thermal decay warning signal if the comparison is unfavorable."

Quak is not prior art to Claim 61. Quak claims priority from U.S. Provisional Application Serial No. 60/222,995 filed on August 4, 2000 (hereinafter the "Quak provisional"). The application claims priority from the provisional (U.S. Provisional Application Serial No. 60/223,444 filed on August 4, 2000). Thus, the Quak provisional was not filed before the provisional, and therefore Quak does not have an earlier effective filing date than the application. See 35 U.S.C. § 102(e).

The Examiner asserts that "the provisional Application is silent in mentioning . . . a test pattern on the track has a different data density than user data on the track."

The chart below sets forth Claim 61 in the left column, the provisional in the middle column, and comments in the right column.

Claim 61	Provisional	Comments
A method for providing an early warning of thermal decay in a disk drive, wherein the disk drive includes a magnetic disk, the disk includes a track, a test pattern on the track has a different data density than user data on the track, and the disk drive stores a reference amplitude, the method comprising:	The proposed thermal decay EARLY Warning procedure is based on the above stated physical principle. (Page 1, line 17). Thermal decay is becoming an increasing concern to the stability of magnetic storage devices. (Page 1, line 3). [T]his can be achieved in a disk drive . . . (Page 1, line 32). In general, for a given magnetic material, the thermal decay rate increases with the increasing demagnetization field. (Page 1, line 10-11). A pattern that decays faster than the signal the device uses for storage, hereafter referred to as Warning Pattern (WP). (Page 1, lines 17-18). [T]he WP pattern is recorded and stored in the drive . . . (Page 1, lines 37-38). [T]he decay of the WP is FASTER than any other pattern used in the device for conventional storage purpose, such as data pattern and servo pattern. (Page 1, lines 27-28). Choose a frequency (transition density) higher than the highest data pattern in the	The warning procedure provides an early warning of thermal decay. The magnetic storage device is a disk drive that contains a magnetic disk. The warning pattern is written on the disk to indicate thermal decay in the disk. The warning pattern is written to a track on the disk, as is conventional if not inherent in disk drives and clear to those skilled in the art. The warning pattern has higher transition density than any other pattern in the disk, such as data patterns and servo patterns. Thus, the warning pattern on the track has different data density than user data on the track. The disk drive reads the warning pattern and measures the amplitude of the warning pattern in the factory. The disk drive stores the measured amplitude of the warning pattern in the factory for later reference.

Claim 61	Provisional	Comments
	device. (Page 1, line 31). The WP will therefore decay considerably earlier than any pattern used for data and servo for this particular drive design. Hence, detecting the decay of the WP pattern offers early warning of the drive's thermal decay. (Page 1, lines 33-35). Certain aspects of the Warning Pattern, such as amplitude, will be measured . . . (Page 1, lines 19-20). For example, VGA register value is when the head is reading the WP pattern is recorded and stored in the drive prior to factory exit . . . (Page 1, lines 37-38). Certain aspects of the Warning Pattern, such as amplitude, will be measured and stored for later reference. (Page 1, lines 19-20).	
reading the test pattern from the track to obtain an observed amplitude;	For example, VGA register value is when the head is reading the WP pattern is recorded and stored in the drive prior to factory exit and in the filed [sic, field], the same VGA register is read (defined by firmware) periodically. (Page 1, lines 37-39).	The disk drive reads the warning pattern in the field and observes the amplitude of the warning pattern.
comparing the reference amplitude to the observed amplitude; and	The reading results are compared to that of the factory stored value to determine the amount of thermal decay over time. (Page 1, lines 39-40).	The disk drive compares the measured amplitude of the warning pattern in the factory to the observed amplitude of the warning pattern in the

Claim 61	Provisional	Comments
		field.
producing a thermal decay warning signal if the comparison is unfavorable.	WP is more stressful thermal wise and the decay of this signal provides an early warning for the entire system. (Page 2, line 12).	The disk drive produces a thermal decay warning signal if the thermal decay is sufficient.

The M.P.E.P. discusses the written description requirement as follows:

> To satisfy the written description requirement, a patent specification must describe the claimed invention in sufficient detail that one skilled in the art can reasonably conclude that the inventor had possession of the claimed invention. (M.P.E.P. § 2163(I), Rev. 4, October 2005, page 2100-172).
>
> An applicant shows possession of the claimed invention by describing the claimed invention with all of its limitations using such descriptive means as words, structures, figures, diagrams, and formulas that fully set forth the claimed invention. (M.P.E.P. § 2163(I), Rev. 4, October 2005, pages 2100-165 and 166).
>
> While there is no *in haec verba* requirement, newly added claim limitations must be supported in the specification through express, implicit, or inherent disclosure. (M.P.E.P. § 2163(I)(B), Rev. 4, October 2005, page 2100-175).
>
> The Examiner, therefore, must have a reasonable basis to challenge the adequacy of the written description requirement. The examiner has the initial burden of presenting by a preponderance of evidence why a person skilled in the art would not recognize in an applicant's disclosure a description of the invention defined by the claims. (M.P.E.P. § 2163.04, Rev. 4, October 2005, pages 2100-186 and 187).

The provisional need only describe the claimed invention in sufficient detail that one skilled in the art can reasonably conclude that the inventors had possession of the claimed invention. Furthermore, the provisional can describe the claimed invention through express, implicit, or inherent disclosure. There is no *in haec verba* requirement.

The provisional describes Claim 61 in sufficient detail that one skilled in the art can reasonably conclude, indeed readily conclude, that the inventors had possession of the claimed subject matter. For instance, the provisional makes clear that the warning pattern on the track has different data density than user data on the track.

The Examiner has the burden of presenting by a preponderance of evidence why a person skilled in the art would not recognize that the provisional reasonably conveys the limitations. Since the Examiner has failed to meet this burden, for this reason alone, the denial of domestic priority is improper. Moreover, the denial of domestic priority has no merit for the reasons discussed above.

Claim 61 distinguishes over Alex in view of Quak regardless of whether Quak is prior art to Claim 61.

Alex fails to teach or suggest performing the refresh operation by reading a test pattern on a track that has different data density than user data on the track. Instead, a user manually writes a first test signal to a disk on a spinstand and then reads the first test signal from the disk to detect changes in the frequency and time domains of the readback signal using a spectrum analyzer and an oscilloscope to develop graphs of readback signal amplitude degradation as a function of time. Thereafter, a disk drive performs a refresh operation on user data on the disk by determining whether a readback signal amplitude of the user data falls below a predetermined fraction of a readback signal amplitude of a second test signal just written to the disk using a refresh indicator based on the graphs as the predetermined fraction. Alex says nothing about the data densities of the user data or the second test signal, much less that the second test signal on a track has different data density than user data on the track.

Quak fails to teach or suggest storing user data on a disk, then writing a test pattern on the disk with different data density than the user data. Instead, Quak determines the initial bit density for each head by writing test tracks with the head using different bit densities, then determines an initial total capacity for the disk drive, then provides an adjusted total capacity for the disk drive that is closer to a desired capacity for the disk drive by adjusting bit density and/or track density, and then provides the disk drive to an end user. Quak says nothing about using a test pattern for a refresh operation or any other operation that involves user data.

Quak fails to teach or suggest adjusting the data density of the second test signal in Alex. There is also no motivation to do so since the refresh operation is performed on user data after the storage capacity is set and the disk drive is provided to an end user. Likewise, there is no motivation to do so since the refresh operation reads the second test signal immediately after it is written. Moreover, using a second test signal with different data density than the user data would disrupt the refresh operation since the refresh indicator (predetermined fraction) is based on a graph (such as graph 3, 4 or 5 in Fig. 1) at a fixed data density (such as 400, 300 or 200 kFCI), thereby rendering Alex unsatisfactory for its intended purpose.

The Examiner asserts that "Alex teach . . . a thermal decay warning signal is generated if said amplitude of said signal derived from said at least a first test pattern is less than a reference amplitude (Col. 2, Lines 49-55 . . . Quak et al. teaches writing different test patterns in which its optimum capacity is being measured by changing the data density (Col. 2, L. 44 to Col. 3, L. 52, Quak further explains that if the data density is too high, the medium will detect an error in the performance and therefore decrease this data density. Hence, Quak et al. teaches that by increasing the data density too much, it has greater susceptibility to an error than if written at a lower data density . . . It would have been obvious to a person of ordinary skill in the art, at the

time the invention was made, to modify Alex's invention with the teaching of Quak et al. in order to achieve a desired capacity."

The cited text in Alex states as follows:

> When the current value of the amplitude falls below the stored value, the data is refreshed. The predetermined fraction is determined by testing the storage medium under realistic conditions until one or more soft errors (or a hard error in another implementation) occurs, followed by dividing the amplitude's value (at the time of error) with the amplitude's value at the time of writing. (Col. 2, lines 49-55).

The cited text in Quak states as follows:

> FIGS. 2, 3 and 4 provide flow diagrams that describe a method of setting storage density values such as track density and bit density for various heads 111 in a disc drive 100 under one embodiment of the present invention. In particular, FIG. 2 describes a process for determining initial track density and bit density settings for the various heads 111, FIG. 3 describes a process for adjusting those settings to achieve a desired capacity for the disc drive 100 while improving margins, and FIG. 4 describes a process for determining if the drive's performance with the track density and bit density adjustments will require the drive capacity to be changed. (Col. 2, lines 44-55).
>
> In step 200 of FIG. 2, the track density for each head 111 in the drive 100 is determined. This can be determined by measuring the actual width of the read and write elements on each head or by writing test tracks with each head 111 and measuring the width of the written track. The track density for each head 111 is initially set independently of the track density of the other heads 111 in the disc drive. At step 202, the total track density for the disc drive 100 is determined by adding the individual track densities from each of the heads 111 in the drive. (Col. 2, lines 56-65).
>
> In step 204, the bit density of each head 111 is determined. This can be accomplished by writing a series of test tracks to the disc 107 and reading the data back. Each test track is written and read using a different bit density. After the tracks are read, the number of errors in the read data is determined and the highest bit density to provide an acceptable number of errors is set as the maximum bit density for the head 111. To provide a margin of

safety, a bit density that is less than the maximum bit density is selected for the head 111. For instance, under one embodiment, the selected bit density is 10 kilobytes per inch less than the maximum bit density. At step 206, the bit densities for the different heads 111 are added together to form a total bit density for the drive 100. (Col. 2, line 66 to Col. 3, line 11).

After the individual and total track densities and bit densities have been determined, the process of FIG. 2 selects nominal track densities and bit densities for the drive 100 at step 208. These nominal values are determined based on the desired capacity for the drive 100. (Col. 3, lines 12-16).

At step 210, the total capacity of the current drive 100 is determined from the individual track densities determined in step 200 and the individual bit densities determined in step 204. Under one embodiment, the total capacity associated with each head 111 is calculated as:

[Equation 1 omitted] EQ. 1

where

$$TCount=(r_{OD} - r_{ID})\cdot TD \qquad \text{EQ. 2}$$

and where TD is the track density for the head, BD is the bit density for the head, r_{OD} is the radius at the outer diameter of the disc associated with the head, r_{ID} is the radius at the inner diameter of the disc, and i provides a track count from track 0 to the maximum track count given by Equation 2. To determine the total capacity for the drive 100, the individual capacities associated with each head 111 are added together. (Col. 3, lines 17-36).

Once the total capacity for the drive 100 and the desired capacity for the drive have been determined, embodiments of the present invention try to adjust the track density and/or bit density of one or more heads 111 to form an adjusted capacity. In particular, the track densities and/or bit densities are adjusted so that there is excess capacity between the adjusted capacity and the desired capacity. In addition, if the initial total capacity of the drive provides excess capacity over the desired capacity, the track densities and/or bit densities are adjusted to reduce that excess as much as possible while keeping the adjusted capacity above the desired capacity. By reducing this excess capacity, embodiments of the present invention improve the margins between the maximum track densities and bit densities for the heads 111 and the track densities and bit densities at which they are operated. (Col. 3, lines 37-52).

The cited text in Alex says nothing about performing the refresh operation using a test pattern on a track that has different data density than user data on the track. Instead, the cited text refers to performing the refresh operation when the readback signal amplitude of the user data as currently read falls below the predetermined fraction of the readback signal amplitude of the user data as previously written.

The cited text in Quak says nothing about a refresh operation. Instead, the cited text refers to determining the initial bit density for each head by writing test tracks with the head using different bit densities, then determining an initial total capacity for the disk drive, and then providing an adjusted total capacity for the disk drive that is closer to a desired capacity for the disk drive.

The Examiner has failed to explain how Alex in view of Quak teaches or suggests performing the refresh operation using a test pattern on the track that has <u>different</u> data density than user data on the track. That is, even if Alex was modified by Quak to achieve a desired capacity, as the Examiner proposes, this would not affect the refresh operation in Alex.

<u>Claim 62 (Group II)</u>

Claim 62 distinguishes over Alex in view of Quak for the reasons set forth above for the Group I claim and further distinguishes over Alex in view of Quak on its own merits since it recites another limitation that is not disclosed by Alex in view of Quak or obvious in view of the Group I claim.

Claim 62 recites "the test pattern is an early warning pattern that has greater susceptibility to thermal decay than any servo information and any user data on the disk."

Alex fails to teach or suggest performing the refresh operation by reading a test pattern on a track that has greater susceptibility to thermal decay than any servo information and any user data on the disk, and Quak fails to cure this deficiency.

The Examiner asserts that "The combination [of Alex and Quak] further teach wherein the test pattern has greater susceptibility to error than any other servo or user data (Quak et al. teaches writing different test patterns in which its optimum capacity is being measured by changing the data density. See Col. 2, L. 44 to Col. 3, L. 52, Quak further explains that if the data density is too high, the medium will detect an error in the performance and therefore decrease this data density. Hence, Quak et al. teaches that by increasing the data density too much, it has greater susceptibility to an error than if written at a lower data density."

The Examiner has failed to explain how Alex in view of Quak teaches or suggests performing the refresh operation using a test pattern that has greater susceptibility to thermal decay than any servo information or user data on the disk. Furthermore, there is no motivation to do so since the refresh operation reads the second test signal immediately after it is written.

The provisional describes Claim 62 in sufficient detail that one skilled in the art can reasonably conclude, indeed readily conclude, that the inventors had possession of the claimed subject matter. The provisional states as follows:

> The key to EARLY Warning lies in the design and construction of the WP and the location (in the storage media) of the WP. The principle in choosing these parameters is such that the decay of the WP is FASTER than any other pattern used in the device for conventional storage purpose, such as data pattern and servo pattern. (Page 1, lines 26-28).
>
> The WP will therefore decay considerably earlier than any pattern used for data and servo for this particular drive design. Hence, detecting the decay of the WP pattern offers early warning of the drive's thermal decay. (Page 1, lines 33-35).

The provisional makes clear that the warning pattern is an early warning pattern that has greater susceptibility to thermal decay than any servo information and any user data on the disk. Therefore, Quak is not prior art to Claim 62.

Claim 63 (Group III)

Claim 63 distinguishes over Alex in view of Quak for the reasons set forth above for the Group I claim and further distinguishes over Alex in view of Quak on its own merits since it recites another limitation that is not disclosed by Alex in view of Quak or obvious in view of the Group I claim.

Claim 63 recites "the test pattern on the track has a higher susceptibility to thermal decay than user data on the track due to the different data density."

Alex fails to teach or suggest performing the refresh operation by reading a test pattern on a track that has greater susceptibility to thermal decay than the user data due to the different data density of the test pattern, and Quak fails to cure this deficiency.

The Examiner asserts that "The combination [of Alex and Quak] further teach wherein the test pattern on the track has higher susceptibility to thermal decay due to different data density (e.g. larger or smaller (Quak et al. teaches writing different test patterns in which its optimum capacity is being measured by changing the data density. See Col. 2, L. 44 to Col. 3, L. 52, Quak further explains that if the data density is too high, the medium will detect an error in the performance and therefore decrease this data density. Hence, Quak et al. teaches that by increasing the data density too much, it has greater susceptibility to an error than if written at a lower data density."

The Examiner has failed to explain how Alex in view of Quak teaches or suggests performing the refresh operation using a test pattern that has greater susceptibility to thermal decay than user data on the track due to the different data density. Furthermore, there is no motivation to do so since the refresh operation reads the second test signal immediately after it is written.

The provisional describes Claim 63 in sufficient detail that one skilled in the art can reasonably conclude, indeed readily conclude, that the inventors had possession of the claimed subject matter. The provisional states as follows:

> The key to EARLY Warning lies in the design and construction of the WP and the location (in the storage media) of the WP. The principle in choosing these parameters is such that the decay of the WP is FASTER than any other pattern used in the device for conventional storage purpose, such as data pattern and servo pattern. (Page 1, lines 26-28).
>
> Choose a frequency (transition density) higher than the highest data pattern in the device. As an example, this can be achieved in a disk drive by writing a 1T pattern of an OD zone in an ID zone. The effective transition density will be much higher than the 1T pattern of that ID zone. The WP will therefore decay considerably earlier than any pattern used for data and servo for this particular drive design. Hence, detecting the decay of the WP pattern offers early warning of the drive's thermal decay. (Page 1, lines 31-35).

The provisional makes clear that the warning pattern has greater susceptibility to thermal decay than user data on the track due to the different data density. Therefore, Quak is not prior art to Claim 63.

Claim 66 (Group IV)

Claim 66 distinguishes over Alex in view of Quak for the reasons set forth above for the Group I claim and further distinguishes over Alex in view of Quak on its own merits since it recites another limitation that is not disclosed by Alex in view of Quak or obvious in view of the Group I claim.

Claim 66 recites "a test pattern on the track has a larger data density than user data on the track."

Alex fails to teach or suggest performing the refresh operation by reading a test pattern on a track that has larger data density than user data on the track, and Quak fails to cure this deficiency.

The Examiner asserts that "the provisional Application is silent in mentioning . . . said test pattern has higher data density than a data density of a user of said track."

The provisional describes Claim 66 in sufficient detail that one skilled in the art can reasonably conclude, indeed readily conclude, that the inventors had possession of the claimed subject matter. The provisional states as follows:

> Choose a frequency (transition density) higher than the highest data pattern in the device. As an example, this can be achieved in a disk drive by writing a 1T pattern of an OD zone in an ID zone. The effective transition density will be much higher than the 1T pattern of that ID zone. The WP will therefore decay considerably earlier than any pattern used for data and servo for this particular drive design. Hence, detecting the decay of the WP pattern offers early warning of the drive's thermal decay. (Page 1, lines 31-35).

The provisional makes clear that the warning pattern on the track has larger data density than user data on the track. Therefore, Quak is not prior art to Claim 66.

<u>Claim 67 (Group V)</u>

Claim 67 distinguishes over Alex in view of Quak for the reasons set forth above for the Group II and IV claims. Furthermore, Quak is not prior art to Claim 67.

<u>Claim 68 (Group VI)</u>

Claim 68 distinguishes over Alex in view of Quak for the reasons set forth above for the Group III and IV claims. Furthermore, Quak is not prior art to Claim 68.

<u>Claim 71 (Group VII)</u>

Claim 71 distinguishes over Alex in view of Quak for the reasons set forth above for the Group I claim and further distinguishes over Alex in view of Quak on its own merits since it recites another limitation that is not disclosed by Alex in view of Quak or obvious in view of the Group I claim.

Claim 71 recites "a test pattern on the track has a <u>smaller</u> data density than user data on the track."

Alex fails to teach or suggest performing the refresh operation by reading a test pattern on a track that has smaller data density than user data on the track, and Quak fails to cure this deficiency.

<u>Claim 72 (Group VIII)</u>

Claim 72 distinguishes over Alex in view of Quak for the reasons set forth above for the Group II and VII claims.

Claim 73 (Group IX)

Claim 73 distinguishes over Alex in view of Quak for the reasons set forth above for the Group III and VII claims.

Claim 76 (Group X)

Claim 76 distinguishes over Alex in view of Quak for the reasons set forth above for the Group I claim and further distinguishes over Alex in view of Quak on its own merits since it recites another limitation that is not disclosed by Alex in view of Quak or obvious in view of the Group I claim.

Claim 76 recites "a test pattern on the track has a different data density than a 1T pattern on the track."

Alex fails to teach or suggest performing the refresh operation by reading a test pattern on a track that has different data density than a 1T pattern on the track, and Quak fails to cure this deficiency.

The Examiner asserts that "the provisional Application is silent in mentioning . . . said test pattern has a different data density than a 1T pattern on the track."

The provisional describes Claim 76 in sufficient detail that one skilled in the art can reasonably conclude, indeed readily conclude, that the inventors had possession of the claimed subject matter. The provisional states as follows:

> Choose a frequency (transition density) higher than the highest data pattern in the device. As an example, this can be achieved in a disk drive by writing a 1T pattern of an OD zone in an ID zone. The effective transition density will be much higher than the 1T pattern of that ID zone. (Page 1, lines 31-33).

The provisional makes clear that the warning pattern on the track has different data density than a 1T pattern on the track. Therefore, Quak is not prior art to Claim 76.

Claim 77 (Group XI)

Claim 77 distinguishes over Alex in view of Quak for the reasons set forth above for the Group II and X claims. Furthermore, Quak is not prior art to Claim 77.

Claims 1, 6-8 and 10 (Group XII)

Claim 1 distinguishes over Alex in view of Quak for the reasons set forth above for the Group IV claim and further distinguishes over Alex in view of Quak on its own merits since it recites another limitation that is not disclosed by Alex in view of Quak or obvious in view of the Group IV claim.

Claim 1 recites "writing a test pattern to a track of a magnetic disk, wherein said test pattern has a higher data density than a data density of user data in said track; measuring an amplitude of a signal produced by reading said test pattern; storing said measured amplitude; reading said test pattern from said track to obtain an observed amplitude of a signal produced by said test pattern; comparing said measured amplitude to said observed amplitude; and producing a thermal decay warning signal if said comparison is unfavorable."

The Examiner asserts that "the provisional Application is silent in mentioning . . . said test pattern has higher data density than a data density of a user of said track."

The chart below sets forth Claim 1 in the left column, the provisional in the middle column, and comments in the right column.

Claim 1	Provisional	Comments
A method for providing an early warning of thermal decay, comprising:	The proposed thermal decay EARLY Warning procedure is based on the above stated physical principle. (Page 1, line 17).	The preamble is explicit.
writing a test pattern to a track of a magnetic disk, wherein said test pattern has a higher data density than a data density of user data in said track;	Thermal decay is becoming an increasing concern to the stability of magnetic storage devices. (Page 1, line 3). In general, for a given magnetic material, the thermal decay rate increases with the increasing demagnetization field. (Page 1, line 10-11). A pattern that decays faster than the signal the device uses for storage, hereafter referred to as Warning Pattern (WP). (Page 1, lines 17-18). [T]he WP pattern is recorded and stored in the drive . . . (Page 1, lines 37-38). [T]he decay of the WP is FASTER than any other pattern used in the device for conventional storage purpose, such as data pattern and servo pattern. (Page 1, lines 27-28). Choose a frequency (transition density) higher than the highest data pattern in the device. (Page 1, line 31). The WP will therefore decay considerably earlier than any pattern used for data and servo for this particular drive design. Hence, detecting the decay of the WP pattern offers early	The magnetic storage device is a disk drive that contains a magnetic disk. The warning pattern is written on the disk to indicate thermal decay in the disk. The warning pattern is written to a track on the disk, as is conventional if not inherent in disk drives and clear to those skilled in the art. The warning pattern has a higher transition density than any other pattern in the disk, such as data patterns and servo patterns. Thus, the warning pattern has a higher data density than user data on the track.

Claim 1	Provisional	Comments
	warning of the drive's thermal decay. (Page 1, lines 33-35).	
measuring an amplitude of a signal produced by reading said test pattern;	Certain aspects of the Warning Pattern, such as amplitude, will be measured . . . (Page 1, lines 19-20). For example, VGA register value is when the head is reading the WP pattern is recorded and stored in the drive prior to factory exit . . . (Page 1, lines 37-38).	The disk drive reads the warning pattern and measures the amplitude of the warning pattern in the factory.
storing said measured amplitude;	Certain aspects of the Warning Pattern, such as amplitude, will be measured and stored for later reference. (Page 1, lines 19-20).	The disk drive stores the measured amplitude of the warning pattern in the factory for later reference.
reading said test pattern from said track to obtain an observed amplitude of a signal produced by said test pattern;	For example, VGA register value is when the head is reading the WP pattern is recorded and stored in the drive prior to factory exit and in the filed [sic, field], the same VGA register is read (defined by firmware) periodically. (Page 1, lines 37-39).	The disk drive reads the warning pattern in the field and observes the amplitude of the warning pattern.
comparing said measured amplitude to said observed amplitude; and	The reading results are compared to that of the factory stored value to determine the amount of thermal decay over time. (Page 1, lines 39-40).	The disk drive compares the measured amplitude of the warning pattern in the factory to the observed amplitude of the warning pattern in the field.
producing a thermal decay warning signal if said comparison is unfavorable	WP is more stressful thermal wise and the decay of this signal provides an early warning for the entire system. (Page 2, line 12).	The disk drive produces a thermal decay warning signal if the thermal decay is sufficient.

The provisional describes Claim 1 in sufficient detail that one skilled in the art can reasonably conclude, indeed readily conclude, that the inventors had possession of the claimed subject matter. The provisional makes clear that the warning pattern on the track has higher data density than user data on the track. Therefore, Quak is not prior art to Claim 1.

Claim 1 distinguishes over Alex in view of Quak regardless of whether Quak is prior art to Claim 1.

Alex fails to teach or suggest performing the refresh operation on a test pattern. Instead, the refresh operation is performed on user data so that the user data can be stored for an indefinite period of time despite the ongoing thermal degradation. Quak says nothing about using a test pattern for a refresh operation or any other operation that involves user data. Thus, Quak fails to cure this deficiency.

The Examiner asserts that "Sacks et al. [sic, Alex] teach . . . writing a test pattern to a magnetic disk . . . (Col. 2, Lines 5-15 and Lines 42-43 and Col. 6, Line 1-7 and Col. 10, Lines 3-10. Alex teaches data tracks being written in the medium and being analyzed by a test circuit, therefore, the tracks being used are tested and considered a test track with a particular test pattern being analyzed by the circuit . . . Measuring an amplitude of a signal produced by reading said test pattern (Col. 2, 43-44 . . . Reading said test pattern to obtain an observed amplitude of a signal produced by said test signal (Col. 6, Lines 25-27) . . . Comparing said measured amplitude to said observed amplitude (Col. 2, Lines 46-50 and Col. 6, Lines 15-23)."

The Examiner admits that "Alex does not explicitly teach wherein the tracks have differing track densities per zone" and then asserts that "Quak et al. teaches the use of zone bit recording, in which differing data densities are recorded into different zones in order to optimize the capacity of the drive (Col. 2, L 44 to Col. 3, L 52 of Quak et al.). It would have been obvious

to a person of ordinary skill in the art, at the time the invention was made, to modify Alex's invention with the teaching of Quak et al. in order to achieve a desired capacity."

The cited text in Alex states as follows:

> An apparatus and method in accordance with the invention write data to a storage medium, e.g., a magnetic medium (such as a hard disk, a floppy disk, or a tape), and refresh the data prior to the occurrence of a non-recoverable error (also called "hard" error) in the data. Specifically, in one embodiment, the data is stored in an areal density that is sufficiently high to cause spontaneous degradation (e.g. loss in amplitude of a readback signal) of the data over time. Whenever necessary, the written data is read and used in the normal manner (although the amplitude of the readback signal reduces with time). (Col. 2, lines 5-15).

> In one example, the apparatus and method read the data back contemporaneous with writing of the data, and measure an amplitude (or other property) of a readback signal, and store as the refresh indicator a predetermined fraction (e.g. half) of the measured value. In this example, the amplitude of the readback signal reduces over time, as the magnetization in the storage medium become disordered (e.g. due to thermal energy). When the current value of the amplitude falls below the stored value, the data is refreshed. (Col. 2, lines 42-50).

> In one embodiment, a computer 8 (FIG. 3) writes (e.g. as illustrated by act 10 in FIG. 4) data to a file (e.g. file 9I in FIG. 3 that is one of a number of files 9-9N, A<I<N, N being the total number of files) in a storage medium, such as a hard disk 11 in a hard disk unit 12. Contemporaneous with (i.e. just before, during, or just after) writing of the data (e.g. within the same day), computer 8 also optionally saves (e.g. as illustrated by act 14 in FIG. 4) a refresh indicator (e.g. indicator 13I in FIG. 3) for later use in deciding on performance of the refresh operation. (Col. 6, lines 1-10).

> If so, (and also in case of a periodic event) computer 8 performs a "refresh" operation, wherein the to-be-refreshed data is read from (as illustrated by act 18) and written back (as illustrated by act 19) to the same file 9I (in this embodiment; in an alternative embodiment, the data is written to a new file in hard disk 12 followed by deletion of the original file). (Col. 6, lines 25-31).

> FIG. 10 illustrates a test circuit 80 used to obtain the data illustrated in FIG. 1. Specifically, test circuit 80 includes a read-write analyzer 81 that supplies a signal to head 43 and that receives a readback signal from the head 43. Analyzer 81 supplies the readback signal (which is undergoing decay) to each of a spectrum analyzer 82 and an oscilloscope 83. Spectrum analyzer 82 and oscilloscope 83 are used by a user to manually detect the change in the readback signal in the frequency and time domains respectively. (Col. 10, lines 3-10).

The cited text in Alex says nothing about performing the refresh operation on a test pattern, much less a test pattern on a track that has higher data density than user data on the track. Instead, the cited text refers to a user manually writing a first test signal to a disk and then reading the first test signal from the disk to detect changes in the frequency and time domains of the readback signal using a spectrum analyzer and an oscilloscope to develop graphs of readback signal amplitude degradation as a function of time, and then a disk drive performing the refresh operation when the readback signal amplitude of the user data as currently read falls below a predetermined fraction of the readback signal amplitude of the user data as previously written.

The cited text in Quak (set forth above for the Group I claim) says nothing about a refresh operation. Instead, the cited text refers to determining the initial bit density for each head by writing test tracks with the head using different bit densities, then determining an initial total capacity for the disk drive, and then providing an adjusted total capacity for the disk drive that is closer to a desired capacity for the disk drive.

The Examiner has failed to explain how Alex in view of Quak teaches or suggests performing the refresh operation on a test pattern, much less a test pattern on a track that has higher data density than user data on the track. That is, even if Alex was modified by Quak to achieve a desired capacity, as the Examiner proposes, this would not affect the refresh operation in Alex.

Claim 4 (Group XIII)

Claim 4 distinguishes over Alex in view of Quak for the reasons set forth above for the Group XII claims and further distinguishes over Alex in view of Quak on its own merits since it recites another limitation that is not disclosed by Alex in view of Quak or obvious in view of the Group XII claims.

Claim 4 recites "identifying a sector of said magnetic disk at which a magnetic medium of said magnetic disk is thinner than an average thickness of said magnetic medium, and then writing said test pattern to said sector in response to said identification."

Alex fails to teach or suggest performing the refresh operation by identifying a sector of the disk at which the magnetic medium is thinner than average and then writing the user data to the sector in response to the identification. Instead, the refresh operation is performed on the disk wherever user data is stored regardless of the thickness of the magnetic medium. Quak says nothing about storing user data on a sector in response to identifying the sector has magnetic medium that is thinner than average. Thus, Quak fails to cure this deficiency.

The Examiner asserts that "Alex further teaches identifying a sector of said magnetic disk at which a magnetic medium comprising an information storing portion of said magnetic disk is thinner than an average magnetic medium thickness of said magnetic disk, and then writing a test pattern to the sector when identified (Col. 5, Lines 7-40. Alex teaches an embodiment of its invention wherein the change the bit spacing and according to Alex, if the bit spacing is changed, the film thickness obviously changed.)."

The cited text states as follows:

> The energy ratio is a function of a number of parameters such as, magnetic anisotropy, film thickness, and temperature of operation. Specifically, as the film thickness is reduced, the volume of each grain is also reduced, and polarity of magnetic

> signals recorded in the grains becomes susceptible to degradation due to thermal energy at room temperature. Moreover, even when the grain size remains the same, recorded signals undergo increasing thermal degradation as the recording density is increased (e.g., by writing transitions closer together either by recording at higher frequencies than normal or by spinning the disk slower than normal). Over time, magnetizations of one or more grains included in a magnetic portion become disordered, resulting in a degradation in the amplitude of readback signal when reading data that was previously stored in the grains. Testing the storage medium under realistic conditions (e.g. at normal operating temperatures, such as in the range 22-80°C., and normal spacing between adjacent magnetizations, such as 100 nm) until a soft error occurs yields the readback signal's amplitude at the time of the error. Such testing can be used to select, as the refresh indicator, a value of the readback signal's amplitude at which a refresh operation is to be performed. (Col. 5, lines 7-30).
>
> So, in one embodiment, the spacing between adjacent magnetized locations of the magnetic medium is kept small enough to ensure that the amplitude of a readback signal degrades spontaneously over time. For example, the spacing can be made smaller than 50 nm (for a recording density of 500 kFCI), so that interactions between fields in adjacent magnetized locations accelerates the degradation in the amplitude, as illustrated in FIG. 1 by lines 3-5 (wherein normalized signal amplitude is plotted along the y axis and time in logarithmic units is plotted along the x axis). (Col. 5, lines 31-40).

The cited text says nothing about performing the refresh operation at a sector in response to identifying reduced film thickness at the sector. Instead, the cited text refers to the recorded signal being more susceptible to thermal degradation as the recording density increases and as the film thickness decreases, and characterizing the degradation in readback signal amplitude as a function of time by plotting graphs 3, 4 and 5 in Fig. 1.

The Examiner has failed to explain how Alex in view of Quak teaches or suggests performing the refresh operation by identifying a sector where the film thickness is thinner than average and then writing the user data to the sector in response to the identification.

The provisional describes Claim 4 in sufficient detail that one skilled in the art can reasonably conclude, indeed readily conclude, that the inventors had possession of the claimed subject matter. The provisional states as follows:

> The key to EARLY Warning lies in the design and construction of the WP and the location (in the storage media) of the WP. (Page 1, lines 26-27).
>
> Measure the servo AGC field for the ID zone. Pick a sector that follows the lowest amplitude. This sector will thus have the lowest Mrt of the disk. Write a 1T pattern on this sector only and use the 1T pattern on this sector as the WP. (Page 2, lines 1-3).

The provisional makes clear that the warning pattern is written to a sector in response to detecting that the sector has the lowest magnetization (Mrt) on the disk. Furthermore, the disk magnetization corresponds to the thickness of the magnetic medium, as is conventional if not inherent in disk drives and clear to those skilled in the art. Thus, the warning pattern is written to a sector in response to detecting that the magnetic medium at the sector is thinner than average. Therefore, Quak is not prior art to Claim 4.

<u>Claim 9 (Group XIV)</u>

Claim 9 distinguishes over Alex in view of Quak for the reasons set forth above for the Group XII claims and further distinguishes over Alex in view of Quak on its own merits since it recites another limitation that is not disclosed by Alex in view of Quak or obvious in view of the Group XII claims.

Claim 9 recites "creating a predetermined portion of said magnetic disk having a greater than average susceptibility to thermal decay during manufacture of said magnetic disk, and then

writing said test pattern to said predetermined portion of said magnetic disk in response to identifying said predetermined portion of said magnetic disk."

Alex fails to teach or suggest performing the refresh operation by identifying a predetermined portion of the disk which has greater than average susceptibility to thermal decay and then writing the user data to the predetermined portion in response to the identification. Instead, the refresh operation is performed on the disk wherever user data is stored regardless of the susceptibility to thermal decay. Quak says nothing about storing user data on a predetermined portion of the disk in response to identifying the predetermined portion has greater than average susceptibility to thermal decay. Thus, Quak fails to cure this deficiency.

The Examiner asserts that "Alex further teaches creating a predetermined portion of said magnetic disk having a greater than average susceptibility to thermal decay during manufacture of said magnetic disk, the test pattern to said predetermined portion of said magnetic disk in response to the identification of that predetermined portion (Col. 2, Lines 10-15 and Lines 42-43 and Col. 6, Line 1-7 and Col. 10, Lines 3-10. Alex teaches data tracks being written in the medium and being analyzed by a test circuit, therefore, the tracks being used are tested and considered a test track with a particular test pattern being analyzed by the circuit. Alex teaches in an invention one disk wherein it records at least one test pattern.)."

The cited text (set forth above for the Group XII claims) says nothing about performing the refresh operation at a predetermined portion of the disk in response to identifying the predetermined portion as having greater than average susceptibility to thermal decay. Instead, the cited text to a user manually writing a first test signal to a disk and then reading the first test signal from the disk to detect changes in the frequency and time domains of the readback signal using a spectrum analyzer and an oscilloscope to develop graphs of readback signal amplitude

degradation as a function of time, and then a disk drive performing the refresh operation when the readback signal amplitude of the user data as currently read falls below a predetermined fraction of the readback signal amplitude of the user data as previously written.

The Examiner has failed to explain how Alex in view of Quak teaches or suggests performing the refresh operation by identifying a predetermined portion of the disk that has greater than average susceptibility to thermal decay and then writing the user data to the predetermined portion in response to the identification.

The provisional describes Claim 9 in sufficient detail that one skilled in the art can reasonably conclude, indeed readily conclude, that the inventors had possession of the claimed subject matter. The provisional states as follows:

> In general, for a given magnetic material, the thermal decay rate increases with the increasing demagnetization field. The demag field is proportional to the magnetization of the material (Mrt). (Page 1, line 10-12).
>
> The key to EARLY Warning lies in the design and construction of the WP and the location (in the storage media) of the WP. (Page 1, lines 26-27).
>
> Measure the servo AGC field for the ID zone. Pick a sector that follows the lowest amplitude. This sector will thus have the lowest Mrt of the disk. Write a 1T pattern on this sector only and use the 1T pattern on this sector as the WP. (Page 2, lines 1-3).

The provisional makes clear that the warning pattern is written to a predetermined portion of the disk that has greater than average susceptibility to thermal decay in response to identifying the predetermined portion. Therefore, Quak is not prior art to Claim 9.

Claims 11, 16-18 and 20 (Group XV)

Claim 11 distinguishes over Alex in view of Quak for the reasons set forth above for the Group VII and XII claims (without regard to higher data density).

Claim 14 (Group XVI)

Claim 14 distinguishes over Alex in view of Quak for the reasons set forth above for the Group XIII and XV claims (without regard to higher data density).

Claim 15 (Group XVII)

Claim 15 distinguishes over Alex in view of Quak for the reasons set forth above for the Group XVI claim and further distinguishes over Alex in view of Quak on its own merits since it recites another limitation that is not disclosed by Alex in view of Quak or obvious in view of the Group XVI claim.

Claim 15 recites "identifying said sector by measuring the amplitude of signals produced by automatic gain control fields, wherein said identified sector is associated with one of said automatic gain control fields producing an amplitude that is less than a nominal amplitude of said automatic gain control fields."

Alex fails to teach or suggest performing the refresh operation by identifying a sector of the disk at which the magnetic medium is thinner than average and then writing the user data to the sector in response to the identification, much less identifying the sector by measuring automatic gain control fields to select an automatic gain control field with less than nominal amplitude.

The Examiner has not even attempted to address this limitation. Instead, the Examiner objected to Claim 5 which recites this limitation.

The provisional describes Claim 15 in sufficient detail that one skilled in the art can reasonably conclude, indeed readily conclude, that the inventors had possession of the claimed subject matter. The provisional states as follows:

> In general, for a given magnetic material, the thermal decay rate increases with the increasing demagnetization field. The demag field is proportional to the magnetization of the material (Mrt). (Page 1, line 10-12).
>
> The key to EARLY Warning lies in the design and construction of the WP and the location (in the storage media) of the WP. (Page 1, lines 26-27).
>
> Measure the servo AGC field for the ID zone. Pick a sector that follows the lowest amplitude. This sector will thus have the lowest Mrt of the disk. Write a 1T pattern on this sector only and use the 1T pattern on this sector as the WP. (Page 2, lines 1-3).

The provisional makes clear that the sector with the lowest amplitude from a servo automatic gain control (AGC) field is selected. Therefore, Quak is not prior art to Claim 15.

<u>Claim 19 (Group XVIII)</u>

Claim 19 distinguishes over Alex in view of Quak for the reasons set forth above for the Group XIV and XV claims (without regard to higher data density).

<u>Claim 36 (Group XIX)</u>

Claim 36 distinguishes over Alex in view of Quak for the reasons set forth above for the Group II, III and XII claims (without regard to different or higher data density) and further

distinguishes over Alex in view of Quak on its own merits since it recites another limitation that is not disclosed by Alex in view of Quak or obvious in view of the Group I claim.

Claim 36 recites "an amplitude of a signal derived from said test pattern in a data track of said data tracks and having a greater susceptibility to thermal decay than user data in said data track is transmitted by said channel, and a thermal decay warning signal is generated if said amplitude of said warning signal is less than a reference amplitude."

The Examiner asserts that "the provisional Application is silent in mentioning . . . an amplitude of a signal derived from said test pattern in a data track of said data tracks and having a greater susceptibility to thermal decay than user data in said data transmitter by said channel."

The chart below sets forth Claim 36 in the left column, the provisional in the middle column, and comments in the right column.

Claim 36	**Provisional**	**Comments**
A hard disk drive, comprising:	Thermal decay is becoming an increasing concern to the stability of magnetic storage devices. (Page 1, line 3). As an example, this can be achieved in a disk drive . . . (Page 1, lines 31-32).	The magnetic storage device is a disk drive.
a base;		The disk drive contains a base, as is conventional if not inherent in disk drives and clear to those skilled in the art.
a magnetic storage disk comprising a magnetic storage material and data tracks;	In general, for a given magnetic material, the thermal decay rate increases with the increasing demagnetization field. (Page 1, line 10-11). This sector will thus have the lowest Mrt of the disk. (Page	The disk drive contains a magnetic disk that contains magnetic storage material. The disk contains data tracks, as is conventional if not inherent in disk drives and clear to those skilled in the art.

Claim 36	Provisional	Comments
	2, lines 1-2).	
a transducer head for reading and writing information to and from said data tracks, wherein said information comprises a test pattern, and said transducer head is movable in a radial direction with respect to said disk to address a selected one of said data tracks;	A pattern that decays faster than the signal the device uses for storage, hereafter referred to as Warning Pattern (WP). (Page 1, lines 17-18). [T]he WP pattern is recorded and stored in the drive . . . (Page 1, lines 37-38).	The disk drive contains a transducer head for reading and writing information to and from the tracks, and the transducer head is movable in a radial direction with respect to the disk to address a selected track, as is conventional if not inherent in disk drives and clear to those skilled in the art. The information includes the warning pattern.
a voice coil motor for moving said transducer head with respect to said data tracks;		The disk drive contains a voice coil motor for moving the transducer head with respect to the tracks, as is conventional if not inherent in disk drives and clear to those skilled in the art.
a controller, interconnected to said voice coil motor, for controlling a position of said transducer head with respect to said data tracks; and		The disk drive contains a controller interconnected to the voice coil motor for controlling a position of the transducer head with respect to the data tracks, as is conventional if not inherent in disk drives and clear to those skilled in the art.
a channel, interconnected to said transducer head, wherein an amplitude of a signal derived from said test pattern in a data track of said data tracks and having a greater susceptibility to thermal decay than user data in said data track is transmitted by said channel, and a thermal decay	The proposed thermal decay EARLY Warning procedure is based on the above stated physical principle. (Page 1, line 17). [T]he decay of the WP is FASTER than any other pattern used in the device for conventional storage purpose,	The disk drive contains a channel interconnected to the transducer head, as is conventional if not inherent in disk drives and clear to those skilled in the art. The warning pattern is written on the disk to indicate thermal decay in the disk.

Claim 36	Provisional	Comments
warning signal is generated if said amplitude of said warning signal is less than a reference amplitude.	such as data pattern and servo pattern. (Page 1, lines 27-28). The WP will therefore decay considerably earlier than any pattern used for data and servo for this particular drive design. Hence, detecting the decay of the WP pattern offers early warning of the drive's thermal decay. (Page 1, lines 33-35). Certain aspects of the Warning Pattern, such as amplitude, will be measured and stored for later reference. (Page 1, lines 19-20). For example, VGA register value is when the head is reading the WP pattern is recorded and stored in the drive prior to factory exit and in the filed [sic, field], the same VGA register is read (defined by firmware) periodically. (Page 1, lines 37-39). The reading results are compared to that of the factory stored value to determine the amount of thermal decay over time. (Page 1, lines 39-40). WP is more stressful thermal wise and the decay of this signal provides an early warning for the entire system. (Page 2, line 12).	The warning pattern is written to a track on the disk, as is conventional if not inherent in disk drives and clear to those skilled in the art. The warning pattern decays earlier than any data or servo pattern. Thus, the warning pattern in the track has greater susceptibility to thermal decay than user data in the track. The disk drive reads the warning pattern and measures the amplitude of the warning pattern in the factory. The disk drive stores the measured amplitude of the warning pattern in the factory for later reference. The disk drive reads the warning pattern in the field and observes the amplitude of the warning pattern. The disk drive compares the measured amplitude of the warning pattern in the factory to the observed amplitude of the warning pattern in the field. The disk drive produces a thermal decay warning signal if the thermal decay is sufficient.

The provisional describes Claim 36 in sufficient detail that one skilled in the art can reasonably conclude, indeed readily conclude, that the inventors had possession of the claimed

subject matter. The provisional makes clear that the warning pattern in the track has greater susceptibility to thermal decay than user data in the track. Therefore, Quak is not prior art to Claim 36.

Claim 36 distinguishes over Alex in view of Quak regardless of whether Quak is prior art to Claim 36.

The Examiner has failed to explain how Alex in view of Quak teaches or suggests performing the refresh operation on a test pattern, much less a test pattern in a track that has greater susceptibility to thermal decay than user data in the track. That is, even if Alex was modified by Quak to achieve a desired capacity, as the Examiner proposes, this would not affect the refresh operation in Alex.

Claims 37-39 (Group XX)

Claim 37 distinguishes over Alex in view of Quak for the reasons set forth above for the Group XIII and XIX claims (without regard to higher data density). Furthermore, Quak is not prior art to Claims 37-39.

Claim 40 (Group XXI)

Claim 40 distinguishes over Alex in view of Quak for the reasons set forth above for the Group XIV and XIX claims (without regard to higher data density). Furthermore, Quak is not prior art to Claim 40.

Claim 43 (Group XXII)

Claim 43 distinguishes over Alex in view of Quak for the reasons set forth above for the Group IV and XIX claims. Furthermore, Quak is not prior art to Claim 43.

Claims 47-51 (Group XXIII)

Claim 47 distinguishes over Alex in view of Quak for the reasons set forth above for the Group I and XII claims (without regard to higher data density) and further distinguishes over Alex in view of Quak on its own merits since it recites another limitation that is not disclosed by Alex in view of Quak or obvious in view of the Group I and XII claims.

Claim 47 recites "a data track of said data tracks has a reduced magnetization capacity" and "an amplitude of a signal derived from said test pattern in said data track and having a different data density in said data track than user data in said data track is transmitted by said channel, and a thermal decay warning signal is generated if said amplitude of said warning signal is less than a reference amplitude."

The Examiner asserts that "the provisional Application is silent in mentioning . . . an amplitude of a signal derived from said test pattern in said data track and having different data density in said data track than user data in data track is transmitter by said channel."

The chart below sets forth Claim 47 in the left column, the provisional in the middle column, and comments in the right column.

Claim 47	Provisional	Comments
A hard disk drive, comprising:	Thermal decay is becoming an increasing concern to the stability of magnetic storage	The magnetic storage device is a disk drive.

Claim 47	Provisional	Comments
	devices. (Page 1, line 3). As an example, this can be achieved in a disk drive . . . (Page 1, lines 31-32).	
a base;		The disk drive contains a base, as is conventional if not inherent in disk drives and clear to those skilled in the art.
a magnetic storage disk comprising a magnetic storage material and data tracks, wherein a data track of said data tracks has a reduced magnetization capacity;	In general, for a given magnetic material, the thermal decay rate increases with the increasing demagnetization field. (Page 1, line 10-11). This sector will thus have the lowest Mrt of the disk. (Page 2, lines 1-2).	The disk drive contains a magnetic disk that contains magnetic storage material. The disk contains data tracks, as is conventional if not inherent in disk drives and clear to those skilled in the art. The sector (and thus the data track) has reduced magnetization capacity.
a transducer head for reading and writing information to and from said data tracks, wherein said information comprises a test pattern, and said transducer head is movable in a radial direction with respect to said disk to address a selected one of said data tracks;	A pattern that decays faster than the signal the device uses for storage, hereafter referred to as Warning Pattern (WP). (Page 1, lines 17-18). [T]he WP pattern is recorded and stored in the drive . . . (Page 1, lines 37-38).	The disk drive contains a transducer head for reading and writing information to and from the tracks, and the transducer head is movable in a radial direction with respect to the disk to address a selected track, as is conventional if not inherent in disk drives and clear to those skilled in the art. The information includes the warning pattern.
a voice coil motor for moving said transducer head with respect to said data tracks;		The disk drive contains a voice coil motor for moving the transducer head with respect to the tracks, as is conventional if not inherent in disk drives and clear to those

Claim 47	Provisional	Comments
		skilled in the art.
a controller, interconnected to said voice coil motor, for controlling a position of said transducer head with respect to said data tracks; and		The disk drive contains a controller interconnected to the voice coil motor for controlling a position of the transducer head with respect to the tracks, as is conventional if not inherent in disk drives and clear to those skilled in the art.
a channel, interconnected to said transducer head, wherein an amplitude of a signal derived from said test pattern in a data track of said data tracks and having a different data density than user data in said data track is transmitted by said channel, and a thermal decay warning signal is generated if said amplitude of said warning signal is less than a reference amplitude.	The proposed thermal decay EARLY Warning procedure is based on the above stated physical principle. (Page 1, line 17). Choose a frequency (transition density) higher than the highest data pattern in the device. (Page 1, line 31). The WP will therefore decay considerably earlier than any pattern used for data and servo for this particular drive design. Hence, detecting the decay of the WP pattern offers early warning of the drive's thermal decay. (Page 1, lines 33-35). Certain aspects of the Warning Pattern, such as amplitude, will be measured and stored for later reference. (Page 1, lines 19-20). For example, VGA register value is when the head is reading the WP pattern is recorded and stored in the drive prior to factory exit and in the filed [sic, field], the same VGA register is read	The disk drive contains a channel interconnected to the transducer head, as is conventional if not inherent in disk drives and clear to those skilled in the art. The warning pattern is written on the disk to indicate thermal decay in the disk. The warning pattern is written to a track on the disk, as is conventional if not inherent in disk drives and clear to those skilled in the art. The warning pattern has higher transition density than any other pattern in the disk, such as data patterns and servo patterns. Thus, the warning pattern in the track has different data density than user data in the track. The disk drive reads the warning pattern and measures the amplitude of the warning pattern in the factory. The disk drive stores the measured amplitude of the

Claim 47	Provisional	Comments
	(defined by firmware) periodically. (Page 1, lines 37-39). The reading results are compared to that of the factory stored value to determine the amount of thermal decay over time. (Page 1, lines 39-40). WP is more stressful thermal wise and the decay of this signal provides an early warning for the entire system. (Page 2, line 12).	warning pattern in the factory for later reference. The disk drive reads the warning pattern in the field and observes the amplitude of the warning pattern. The disk drive compares the measured amplitude of the warning pattern in the factory to the observed amplitude of the warning pattern in the field. The disk drive produces a thermal decay warning signal if the thermal decay is sufficient.

The provisional describes Claim 47 in sufficient detail that one skilled in the art can reasonably conclude, indeed readily conclude, that the inventors had possession of the claimed subject matter. The provisional makes clear that the warning pattern in the track has different data density than user data in the track. Therefore, Quak is not prior art to Claim 47.

Claim 47 distinguishes over Alex in view of Quak regardless of whether Quak is prior art to Claim 47.

The Examiner has failed to explain how Alex in view of Quak teaches or suggests performing the refresh operation on a test pattern, much less a test pattern in a track that has different data density than user data in the track, and the track having reduced magnetization capacity. That is, even if Alex was modified by Quak to achieve a desired capacity, as the Examiner proposes, this would not affect the refresh operation in Alex.

Claim 52 (Group XXIV)

Claim 52 distinguishes over Alex in view of Quak for the reasons set forth above for the Group IV and XXIII claims. Furthermore, Quak is not prior art to Claim 52.

Claim 81 (Group XXV)

Claim 81 distinguishes over Alex in view of Quak for the reasons set forth above for the Group XIV claim (without regard to higher data density) and further distinguishes over Alex in view of Quak on its own merits since it recites another limitation that is not disclosed by Alex in view of Quak or obvious in view of the Group I claim.

Claim 81 recites "identifying a sector on the disk that has a greater than average susceptibility to thermal decay; writing a test pattern to the sector in response to identifying the sector; reading the test pattern from the sector to obtain a reference amplitude; storing the reference amplitude in the disk drive; reading the test pattern from the sector to obtain a measured amplitude; comparing the reference amplitude and the measured amplitude; and producing a thermal decay warning signal if the comparison is unfavorable."

The Examiner asserts that "the provisional Application is silent in mentioning . . . identifying a sector on the disk that has a greater than average susceptibility to thermal decay."

The chart below sets forth Claim 81 in the left column, the provisional in the middle column, and comments in the right column.

Claim 81	Provisional	Comments
A method for providing an early warning of thermal decay in a disk drive, wherein the disk drive includes a magnetic disk, the method comprising the following steps	The proposed thermal decay EARLY Warning procedure is based on the above stated physical principle. (Page 1, line 17).	The warning procedure provides an early warning of thermal decay. The magnetic storage device is a disk drive that contains a

Claim 81	Provisional	Comments
in the sequence set forth:	Thermal decay is becoming an increasing concern to the stability of magnetic storage devices. (Page 1, line 3). [T]his can be achieved in a disk drive . . . (Page 1, line 32). In general, for a given magnetic material, the thermal decay rate increases with the increasing demagnetization field. (Page 1, line 10-11).	magnetic disk.
identifying a sector on the disk that has a greater than average susceptibility to thermal decay;	The key to EARLY Warning lies in the design and construction of the WP and the location (in the storage media) of the WP. (Page 1, lines 26-27). Measure the servo AGC field for the ID zone. Pick a sector that follows the lowest amplitude. This sector will thus have the lowest Mrt of the disk. (Page 2, lines 1-2)	A sector is selected that has the lowest Mrt on the disk. Thus, the sector has greater than average susceptibility to thermal decay.
writing a test pattern to the sector in response to identifying the sector;	A pattern that decays faster than the signal the device uses for storage, hereafter referred to as Warning Pattern (WP). (Page 1, lines 17-18). [T]he WP pattern is recorded and stored in the drive . . . (Page 1, lines 37-38). [T]he decay of the WP is FASTER than any other pattern used in the device for conventional storage purpose, such as data pattern and servo	The disk drive writes the warning pattern to the sector in the factory in response to selecting the sector. The warning pattern indicates thermal decay in the disk.

Claim 81	Provisional	Comments
	pattern. (Page 1, lines 27-28). The WP will therefore decay considerably earlier than any pattern used for data and servo for this particular drive design. Hence, detecting the decay of the WP pattern offers early warning of the drive's thermal decay. (Page 1, lines 33-35). Write a 1T pattern on this sector only and use the 1T pattern on this sector as the WP. (Page 2, lines 2-3)	
reading the test pattern from the sector to obtain a reference amplitude;	For example, VGA register value is when the head is reading the WP pattern is recorded and stored in the drive prior to factory exit . . . (Page 1, lines 37-38).	The disk drive reads the warning pattern from the sector and obtains the measured amplitude in the factory.
storing the reference amplitude in the disk drive;	Certain aspects of the Warning Pattern, such as amplitude, will be measured and stored for later reference. (Page 1, lines 19-20).	The disk drive stores the measured amplitude of the warning pattern in the factory for later reference.
reading the test pattern from the sector to obtain a measured amplitude;	For example, VGA register value is when the head is reading the WP pattern is recorded and stored in the drive prior to factory exit and in the filed [sic, field], the same VGA register is read (defined by firmware) periodically. (Page 1, lines 37-39).	The disk drive reads the warning pattern from the sector in the field and observes the amplitude of the warning pattern.
comparing the reference amplitude and the measured amplitude; and	The reading results are compared to that of the factory stored value to determine the amount of thermal decay over time. (Page 1, lines 39-40).	The disk drive compares the measured amplitude of the warning pattern in the factory to the observed amplitude of the warning pattern in the

Claim 81	Provisional	Comments
		field.
producing a thermal decay warning signal if the comparison is unfavorable.	WP is more stressful thermal wise and the decay of this signal provides an early warning for the entire system. (Page 2, line 12).	The disk drive produces a thermal decay warning signal if the thermal decay is sufficient.

The provisional describes Claim 81 in sufficient detail that one skilled in the art can reasonably conclude, indeed readily conclude, that the inventors had possession of the claimed subject matter. The provisional makes clear that the warning pattern is written to a sector that has greater than average susceptibility to thermal decay in response to identifying the sector. Therefore, Quak is not prior art to Claim 81.

Claim 81 distinguishes over Alex in view of Quak regardless of whether Quak is prior art to Claim 81.

The Examiner has failed to explain how Alex in view of Quak teaches or suggests performing the refresh operation on a test pattern, much less a test pattern written to a sector that has greater than average susceptibility to thermal decay in response to identifying the sector. That is, even if Alex was modified by Quak to achieve a desired capacity, as the Examiner proposes, this would not affect the refresh operation in Alex.

Claim 82 (Group XXVI)

Claim 82 distinguishes over Alex in view of Quak for the reasons set forth above for the Group XXV claim and further distinguishes over Alex in view of Quak on its own merits since it recites another limitation that is not disclosed by Alex in view of Quak or obvious in view of the Group I claim.

Claim 82 recites "reading servo information from the disk to obtain measured servo amplitudes; and determining a portion of the disk that has a greater than average susceptibility to thermal decay based on the measured servo amplitudes, wherein the sector is associated with the portion of the disk."

Alex fails to teach or suggest performing the refresh operation by identifying a sector that has greater than average susceptibility to thermal decay, much less identifying the sector by reading servo information from the disk to obtain measured servo amplitudes, and Quak fails to cure this deficiency.

The Examiner asserts that "The combination [of Alex and Quak] further teach wherein the test pattern has greater susceptibility to error than any other servo or user data (Quak et al. teaches writing different test patterns in which its optimum capacity is being measured by changing the data density. See Col. 2, L. 44 to Col. 3, L. 52, Quak further explains that if the data density is too high, the medium will detect an error in the performance and therefore decrease this data density. Hence, Quak et al. teaches that by increasing the data density too much, it has greater susceptibility to an error than if written at a lower data density."

The Examiner has failed to explain how Alex in view of Quak teaches or suggests performing the refresh operation by identifying a sector that has greater than average susceptibility to thermal decay, much less identifying the sector by reading servo information from the disk to obtain measured servo amplitudes.

The provisional describes Claim 82 in sufficient detail that one skilled in the art can reasonably conclude, indeed readily conclude, that the inventors had possession of the claimed subject matter. The provisional states as follows:

> In general, for a given magnetic material, the thermal decay rate increases with the increasing demagnetization field. The

> demag field is proportional to the magnetization of the material (Mrt). (Page 1, line 10-12).
>
> The key to EARLY Warning lies in the design and construction of the WP and the location (in the storage media) of the WP. (Page 1, lines 26-27).
>
> Measure the servo AGC field for the ID zone. Pick a sector that follows the lowest amplitude. This sector will thus have the lowest Mrt of the disk. Write a 1T pattern on this sector only and use the 1T pattern on this sector as the WP. (Page 2, lines 1-3).

The provisional makes clear that the sector is identified by reading servo information from the disk to identify the sector with greater than average susceptibility to thermal decay. Therefore, Quak is not prior art to Claim 82.

<u>Claim 86 (Group XVII)</u>

Claim 86 distinguishes over Alex in view of Quak for the reasons set forth above for the Group II and XXV claims (without regard to different data density).

The Examiner asserts that "the provisional Application is silent in mentioning . . . the test pattern has a greater susceptibility to thermal decay than any servo information and any user data on the disk."

The provisional describes Claim 86 in sufficient detail that one skilled in the art can reasonably conclude, indeed readily conclude, that the inventors had possession of the claimed subject matter. The provisional states as follows:

> The key to EARLY Warning lies in the design and construction of the WP and the location (in the storage media) of the WP. The principle in choosing these parameters is such that the decay of the WP is FASTER than any other pattern used in the device for conventional storage purpose, such as data pattern and servo pattern. (Page 1, lines 26-28).

> The WP will therefore decay considerably earlier than any pattern used for data and servo for this particular drive design. Hence, detecting the decay of the WP pattern offers early warning of the drive's thermal decay. (Page 1, lines 33-35).

The provisional makes clear that the warning pattern is an early warning pattern that has greater susceptibility to thermal decay than any servo information and any user data on the disk. Therefore, Quak is not prior art to Claim 86.

Claim 87 (Group XVIII)

Claim 87 distinguishes over Alex in view of Quak for the reasons set forth above for the Group XXVI and XXVII claims. Furthermore, Quak is not prior art to Claim 87.

Claim 91 (Group XXIX)

Claim 91 distinguishes over Alex in view of Quak for the reasons set forth above for the Group XXV claim and further distinguishes over Alex in view of Quak on its own merits since it recites another limitation that is not disclosed by Alex in view of Quak or obvious in view of the Group XXV claim.

Claim 91 recites "reading the test pattern from the sector to obtain a reference amplitude . . . [then] shipping the disk drive from a factory to an end user . . . [and then] reading the test pattern from the sector to obtain a measured amplitude."

Alex fails to teach or suggest performing the refresh operation writing the user data to the disk, then shipping the disk drive from a factory to an end user, and then reading the user data from the disk, and Quak fails to cure this deficiency.

The Examiner has not even attempted to address this limitation.

The Examiner asserts that "the provisional Application is silent in mentioning . . . shipping the disk drive froma a factory to an end user."

The provisional describes Claim 91 in sufficient detail that one skilled in the art can reasonably conclude, indeed readily conclude, that the inventors had possession of the claimed subject matter. The provisional states as follows:

> The warning pattern will be written in prior to shipping out of the factory. (Page 1, line 19).
>
> For example, VGA register value is when the head is reading the WP pattern is recorded and stored in the drive prior to factory exit and in the filed [sic, field], the same VGA register is read (defined by firmware) periodically. (Page 1, lines 37-39).

The provisional makes clear that the warning pattern is written to the disk and then read from the disk to obtain the reference amplitude while the disk drive is at the factory, then the disk drive is shipped to an end user (in the field), and then the warning pattern is read from the disk to obtain the measured amplitude. Therefore, Quak is not prior art to Claim 91.

Claim 92 (Group XXX)

Claim 92 distinguishes over Alex in view of Quak for the reasons set forth above for the Group XXVI and XXIX claims. Furthermore, Quak is not prior art to Claim 92.

3. Claim Rejections Under 35 U.S.C. § 103(a) – Alex, Quak and Emo

The Examiner rejected Claims 3, 41, 42, 65, 70 and 75 under 35 U.S.C. § 103(a) as being unpatentable over Alex and Quak and further in view of Emo.

Emo

Emo discloses a disk drive in which zone boundaries and read/write frequencies within the zones are established based on the read/write transducer – media surface combination performance, thereby implementing a variable zone layout.

The disk drive is assembled in Fig. 12A by building a head/disk assembly (step 1201), then writing servo information using a servo track writer (step 1202), then mating the head/disk assembly with a circuit board (step 1203), then measuring the recording performance of the heads (step 1206) and then generating the zone layout based on the measured head performance (step 1207).

The disk drive is assembled in Fig. 12D by pretesting the recording performance of the heads using a standard disk media (step 1200), then building a head/disk assembly (step 1201-1), then writing servo information using a servo track writer (step 1202), then mating the head/disk assembly with a circuit board (step 1203) and then generating the zone layout based on the measured head performance (step 1207).

Alex, Quak and Emo

Alex and Quak in view of Emo might suggest that a user manually writes a first test signal to a disk using a head and then reads the first test signal from the disk using the head and detects changes in the frequency and time domains of the readback signal using a spectrum analyzer and an oscilloscope to develop graphs of readback signal amplitude degradation as a function of time for various frequencies as described in Alex, then providing a disk drive that adjusts the bit density and track density for the head and the disk so that the disk drive has an adjusted total capacity that is closer to the desired capacity as described in Quak and providing

the disk drive with a variable zone layout as described in Emo, and then writing data to the disk using the head, reading the data from the disk using the head and then refreshing the data on the disk using the head and a refresh indicator based on the graphs as described in Alex.

Claim 65 (Group I)

Claim 65 recites "the disk includes first and second zones, the track is located in the first zone, and the test pattern has the same data density as user data in the second zone."

Alex fails to teach or suggest performing the refresh operation by reading a test pattern on a track in a first zone on the disk that has different data density than user data on the track, much less the test pattern has the same data density as user data in a second zone on the disk. Quak and Emo say nothing about using a test pattern for a refresh operation or any other operation that involves user data. Thus, Quak and Emo fail to cure this deficiency.

The Examiner admits that "The combination [of Alex and Quak] does not explicitly teach wherein the disk includes the first and second zone, the track located in the first zone, and the test pattern has the same data density as user data in the second zone" and then asserts that "(Col. 18, L. 20-41. Emo teaches that each zone has its own frequency in order to optimize head to disc performance when performing read/write operations. But the overall data density in the disk is the same as mentioned n the Summary of the Invention of Emo et al.)."

The cited text states as follows:

> The foregoing technique is in contrast to the prior art where the zone boundaries for all surfaces were aligned and a given track was in the same zone on all surfaces. Since in the prior art all zones and tracks on all surfaces coincided, only one table of zone boundaries (giving track-to-zone correspondence) was required. (Col. 18, lines 15-20).

> Referring to FIG. 8, a stack of disks, including disk 8 and disk 9, is illustrated, for simplicity, without components to rotate the disk nor with read/write transducers for reproducing information from the disks. Disks 8 and 9 include a magnetic coating on their respective surfaces for the record and playback of information. The center lines of disk 8 and 9 are indicated, respectively, by C8 and C9, and it will be appreciated that their center lines C8 and C9 are aligned. For simplicity, the zone boundaries are indicated only on the upper surface of the respective disks. Referring to disk 8, the boundaries of zones Z6, Z7, Z8, Z9 and Z10 are indicated with respect to radii from center line C8. For example, the inner and outer zone boundaries for zone Z7 are defined by distances R2 and R3, respectively. As illustrated, R6 indicates the outer diameter of disk 8. The zone boundaries have been established based on the math and Tables described herein, and illustrate a hypothetical result based on testing a read/write head to be used with surface 10. The read/write frequency utilized in the respective zones is unique for the zone and is established based upon factors, including head performance. (Col. 18, lines 21-41).

The cited text says nothing about a writing a test pattern to a first zone that has different data density than user data in the first zone and the same data density as user data in a second zone. Instead, the cited text refers to establishing zone boundaries and zone read/write frequencies based on testing the read/write heads.

The Examiner has failed to explain how Alex and Quak in view of Emo teaches or suggests performing the refresh operation on a test pattern, much less a test pattern on a track in a first zone on the disk that has different data density than user data on the track and the same data density as user data in a second zone on the disk. That is, even if Alex was modified by Quak to achieve a desired capacity and modified by Emo to achieve a variable zone layout, as the Examiner proposes, this would not affect the refresh operation in Alex.

The provisional describes Claim 65 in sufficient detail that one skilled in the art can reasonably conclude, indeed readily conclude, that the inventors had possession of the claimed subject matter. The provisional states as follows:

> As an example, this can be achieved in a disk drive by writing a 1T pattern of an OD zone in an ID zone. The effective transition density will be much higher than the 1T pattern of that ID zone. (Page 1, lines 31-33).

The provisional makes clear that the warning pattern is written to the inner diameter (ID) zone with a transition density of the outer diameter (OD) zone that is much higher than the transition density of the inner diameter zone. Therefore, Quak is not prior art to Claim 65.

Claim 70 (Group II)

Claim 70 distinguishes over Alex and Quak in view of Emo for the reasons set forth above for Claim 66 and the Group I claim. Furthermore, Quak is not prior art to Claim 70.

Claim 75 (Group III)

Claim 75 distinguishes over Alex and Quak in view of Emo for the reasons set forth above for Claim 71 and the Group I claim.

Claim 3 (Group IV)

Claim 3 recites "said track is located within a first zone of said magnetic disk, said test frequency is a nominal data frequency for user data in a second zone of said magnetic disk, and said first zone is located towards an inside diameter of said magnetic disk relative to said second zone."

Claim 3 distinguishes over Alex and Quak in view of Emo for the reasons set forth above for Claim 1 and the Group I claim. Furthermore, Quak is not prior art to Claim 3.

The Examiner admits that "The combination [of Alex and Quak] does not explicitly teach wherein the track located within a first zone in the disk, said test frequency is a nominal frequency for a user data in a second zone of the disk, and the first zone is located towards an inside diameter relative to said second zone" and then asserts that "this feature is well known in the art as disclosed by Emo et al., wherein it teaches a disk divided in a plurality of zones, each zone with its own recording frequency (Pat. No. 6,091,559; Col. 18, L. 20-41. Emo teaches that each zone has its own frequency in order to optimize head to disc performance when performing read/write operations.). It would have been obvious to a person of ordinary skill in the art, at the time the invention was made, to modify the combination's invention with the teaching of Emo et al. in order to provide different frequencies in the zones in order to optimize head to disk performance (Col. 17, Lines 53 to Col. 18, L. 41)."

The cited text (beyond that set forth above for the Group I claim) states as follows:

> As will be appreciated by reference to FIG. 6, since the zone boundaries are not aligned from surface to surface, a specified track on one surface (for example track 280 pointed out above) may not necessarily be operating at a read/write frequency which is the same as the corresponding track for another surface. In the convention used herein, the higher the zone number, the higher the read/write frequency for that zone. More particularly, the read/write frequency for track 280 on surface 6 is higher than the read/write frequency for tack 280 on surface 5. Also, within each zone the read/write frequency is constant. Thus the read/write frequency for a particular track is dependent on the zone in which that track is located, and the zone layout varies from surface to surface in the adaptive zone technique of the present invention. Accordingly, a lookup table is utilized for each head-surface combination to store the track number-to-zone correspondence. Since the read/write frequency for each zone is set, the read/write frequency for the track is a given based on the zone in which the track is located. A lookup table, as illustrated in

FIG. 7 is provided for tracks 0 through 1050 for surfaces 5 and 6 of disk 4. In the lookup table, the beginning track number is given for each zone on the head-surface combinations, for example read/write HD#4-surface 6, and read/write head HD#1-surface 5. Considering read/write head HD#4 as an example, tracks 0-149 are in zone 7, tracks 150-299 are in zone 6, and similarly continuing to final zone on surface 6, zone 3, which contains tracks 800-1050. The zone boundaries are calculated using the zone definition math described above. (Col. 17, line 53 to Col. 18, line 41).

The cited text says nothing about a writing a test pattern to a first zone that has different data density than user data in the first zone and the same data density as user data in the second zone. Instead, the cited text refers to establishing zone boundaries and zone read/write frequencies based on testing the read/write heads.

The Examiner has failed to explain how Alex and Quak in view of Emo teaches or suggests performing the refresh operation on a test pattern, much less a test pattern on a track in a first zone on the disk that has different data density than user data on the track and the same data density as user data in a second zone on the disk. That is, even if Alex was modified by Quak to achieve a desired capacity and modified by Emo to achieve a variable zone layout, as the Examiner proposes, this would not affect the refresh operation in Alex.

Claim 41 (Group V)

Claim 41 distinguishes over Alex and Quak in view of Emo for the reasons set forth above for Claim 36 and the Group IV claim.

Claim 42 (Group VI)

Claim 42 distinguishes over Alex and Quak in view of Emo for the reasons set forth above for Claim 36 and the Group IV claim.

4. Claim Rejections Under 35 U.S.C. § 103(a) – Alex, Quak and Young

The Examiner rejected Claims 83, 88 and 93 under 35 U.S.C. § 103(a) as being unpatentable over Alex and Quak and further in view of Young.

Young

Young discloses designing bit density for a disk drive. The desired capacity for each disk surface is selected, and the number of data fields (which each store 512 bytes) is selected for each disk surface to meet the desired capacity. The number of zones for each disk surface is determined based on the selected number of data fields for the disk surface and the bits per inch (BPI) profile for the disk surface. The zones each contain a selected number of data fields and a unique write frequency for the data fields. Thereafter, the write frequency for each zone is incrementally decreased to determine a minimum (optimized) write frequency for the zone that allows writing the selected number of data fields in the zone. The optimized write frequencies are stored in a zone table for subsequent use by a disk drive. As a result, the areal density is reduced without reducing the storage capacity.

Alex, Quak and Young

Alex and Quak in view of Young might suggest that a user manually writes a first test signal to a disk using a head and then reads the first test signal from the disk using the head and detects changes in the frequency and time domains of the readback signal using a spectrum analyzer and an oscilloscope to develop graphs of readback signal amplitude degradation as a function of time for various frequencies as described in Alex, then providing a disk drive with optimized bit density for the zones as described in Young that adjusts the bit density and track

density for the head and the disk so that the disk drive has an adjusted total capacity that is closer to the desired capacity as described in Quak, and then writing data to the disk using the head, reading the data from the disk using the head and then refreshing the data on the disk using the head and a refresh indicator based on the graphs as described in Alex.

Claim 83 (Group I)

Claim 83 recites "[reading servo information from the disk to obtain measured servo amplitudes; and determining a portion of the disk that has a greater than average susceptibility to thermal decay based on the measured servo amplitudes, wherein the sector is associated with the portion of the disk and] the servo information is automatic gain control information."

Alex fails to teach or suggest performing the refresh operation by identifying a sector that has greater than average susceptibility to thermal decay, much less identifying the sector by reading automatic gain control information from the disk to obtain measured servo amplitudes. Quak and Young say nothing about using a test pattern for a refresh operation or any other operation that involves user data. Thus, Quak and Young fail to cure this deficiency.

The Examiner admits that "The combination [of Alex and Quak] does not explicitly teach wherein the servo information is automatic gain control" and then asserts that "Young teaches that the servo information contains an automatic gain control field in Fig. 4, Element 254. It would have been obvious to a person of ordinary skill in the art, at the time the invention was made, to modify the combination's invention with the teaching of Young in order to control the read channel elements."

The Examiner has failed to explain how Alex and Quak in view of Young teaches or suggests performing the refresh operation by identifying a sector that has greater than average

susceptibility to thermal decay, much less identifying the sector by reading automatic gain control information from the disk to obtain measured servo amplitudes. That is, even if Alex was modified by Quak to achieve a desired capacity and modified by Young to achieve optimized bit density, as the Examiner proposes, this would not affect the refresh operation in Alex.

The provisional describes Claim 83 in sufficient detail that one skilled in the art can reasonably conclude, indeed readily conclude, that the inventors had possession of the claimed subject matter. The provisional states as follows:

> In general, for a given magnetic material, the thermal decay rate increases with the increasing demagnetization field. The demag field is proportional to the magnetization of the material (Mrt). (Page 1, line 10-12).
>
> The key to EARLY Warning lies in the design and construction of the WP and the location (in the storage media) of the WP. (Page 1, lines 26-27).
>
> Measure the servo AGC field for the ID zone. Pick a sector that follows the lowest amplitude. This sector will thus have the lowest Mrt of the disk. Write a 1T pattern on this sector only and use the 1T pattern on this sector as the WP. (Page 2, lines 1-3).

The provisional makes clear that the sector is identified by reading automatic gain control information from the disk to identify the sector with greater than average susceptibility to thermal decay. Therefore, Quak is not prior art to Claim 83.

Claim 88 (Group II)

Claim 88 distinguishes over Alex and Quak in view of Young for the reasons set forth above for Claim 86 and the Group I claim. Furthermore, Quak is not prior art to Claim 88.

Claim 93 (Group III)

Claim 93 distinguishes over Alex and Quak in view of Young for the reasons set forth above for Claim 91 and the Group I claim. Furthermore, Quak is not prior art to Claim 93.

5. Claim Rejections Under 35 U.S.C. § 103(a) – Alex, Quak and Ishida

The Examiner rejected Claims 84, 85, 89, 90, 94 and 95 under 35 U.S.C. § 103(a) as being unpatentable over Alex and Quak and further in view of Ishida.

Ishida

Ishida discloses a master information carrier that records preformated servo signals, address signals and clock signals on a disk. The master information carrier contains a protruding (embossed) pattern that represents the servo signals, address signals and clock signals as shown in Fig. 1. However, the master information carrier does not affect the data area of the disk as shown in Figs. 1, 15, 19a and 19b.

The master information carrier can be fabricated by depositing a ferromagnetic film on a substrate and then forming the embossed pattern in the ferromagnetic film as shown in Figs. 2 and 3. The ferromagnetic film can be patterned using a master stamper, photolithography with light exposure, lithography with a laser, electron beam or dry etching, or direct write with a laser, electron beam or ion beam. Alternatively, the master information carrier can be fabricated by forming the embossed pattern in a substrate and then depositing a ferromagnetic film on the substrate as shown in Fig. 4. Alternatively, the master information carrier can be fabricated by forming the embossed pattern in a ferromagnetic film without a substrate as shown in Fig. 5.

The substrate can be glass, polycarbonate, aluminum, silicon or carbon, the ferromagnetic film can be a soft, semihard or hard magnetic material, and the ferromagnetic film can be deposited on the substrate by plating, sputtering, vacuum vapor deposition or chemical vapor deposition.

The master information carrier can record the servo signals, address signals and clock signals on a longitudinal recording disk by making uniform and secure contact between the master information carrier and the disk and magnetizing the master information carrier in parallel with the disk as shown in Fig. 6A. The applied magnetic field is alternating and decaying to obtain sufficient saturation writing. Other magnetization schemes are shown in Figs. 7 and 8.

The master information carrier can record the servo signals, address signals and clock signals on a perpendicular recording disk by making uniform and secure contact between the master information carrier and the disk and magnetizing the master information carrier perpendicular to the disk as shown in Fig. 9A.

The embossed pattern can have a section profile that has rectangular shape as shown in Figs. 2-5, or alternatively a trapezoidal shape as shown in Fig. 10, or alternatively an upside-down trapezoidal shape as shown in Fig. 11.

Alex, Quak and Ishida

Alex and Quak in view of Ishida might suggest that a user manually writes a first test signal to a disk using a head and then reads the first test signal from the disk using the head and detects changes in the frequency and time domains of the readback signal using a spectrum analyzer and an oscilloscope to develop graphs of readback signal amplitude degradation as a function of time for various frequencies as described in Alex, then recording servo signals,

address signals and clock signals on the disk using a master information carrier as described in Ishida, then providing a disk drive that adjusts the bit density and track density for the head and the disk so that the disk drive has an adjusted total capacity that is closer to the desired capacity as described in Quak, and then writing data to the disk using the head, reading the data from the disk using the head and then refreshing the data on the disk using the head and a refresh indicator based on the graphs as described in Alex.

<u>Claim 84 (Group I)</u>

Claim 84 recites "identifying the sector includes determining a portion of the disk in which magnetic media of the disk is thinner than an average thickness of the magnetic media of the disk, and the sector is associated with the portion of the disk."

Alex fails to teach or suggest performing the refresh operation by identifying a sector that has greater than average susceptibility to thermal decay, much less identifying the sector by determining a portion of the disk in which magnetic media is thinner than average. Quak and Ishida say nothing about using a test pattern for a refresh operation or any other operation that involves user data or identifying a sector on the disk where the magnetic media is thinner than average. Thus, Quak and Ishida fail to cure this deficiency.

The Examiner admits that "The combination [of Alex and Quak] does not explicitly teach wherein the film thickness is varied in the sector areas of the disk" and then asserts that "Ishida et al. teaches in Fig. 2 Howe the medium film thickness, Element 22, is varied according to the sector protruding portions. It would have been obvious to a person of ordinary skill in the art, at the time the invention was made, to modify the combination's invention with the teaching of Ishida et al. in order to be able to make an embossed pattern in the disk."

Ishida fails to teach or suggest making an embossed pattern in the disk. Instead, the embossed pattern is made in the master information carrier which records servo signals, address signals and clock signals on the disk.

The Examiner has failed to explain how Alex and Quak in view of Ishida teaches or suggests performing the refresh operation by identifying a sector where the magnetic media is thinner than average and then writing the user data to the sector in response to the identification. That is, even if Alex was modified by Quak to achieve a desired capacity and modified by Ishida to record preformated signals on the disk, as the Examiner proposes, this would not affect the refresh operation in Alex.

The provisional describes Claim 84 in sufficient detail that one skilled in the art can reasonably conclude, indeed readily conclude, that the inventors had possession of the claimed subject matter. The provisional states as follows:

> The key to EARLY Warning lies in the design and construction of the WP and the location (in the storage media) of the WP. (Page 1, lines 26-27).
>
> Measure the servo AGC field for the ID zone. Pick a sector that follows the lowest amplitude. This sector will thus have the lowest Mrt of the disk. Write a 1T pattern on this sector only and use the 1T pattern on this sector as the WP. (Page 2, lines 1-3).

The provisional makes clear that the warning pattern is written to a sector in response to detecting that the sector has the lowest magnetization (Mrt) on the disk. Furthermore, the disk magnetization corresponds to the thickness of the magnetic media, as is conventional if not inherent in disk drives and clear to those skilled in the art. Thus, the warning pattern is written to a sector in response to detecting that the magnetic media at the sector is thinner than average. Therefore, Quak is not prior art to Claim 84.

Claim 85 (Group II)

Claim 85 distinguishes over Alex and Quak in view of Ishida for the reasons set forth above for the Group I claim and further distinguishes over Alex and Quak in view of Ishida on its own merits since it recites another limitation that is not disclosed by Alex and Quak in view of Ishida or obvious in view of the Group I claim.

Claim 85 recites "identifying the sector includes manufacturing the disk so that magnetic media in a predetermined portion of the disk is thinner than an average thickness of the magnetic media in the disk, and the sector is associated with the predetermined portion of the disk."

Alex fails to teach or suggest performing the refresh operation by identifying a sector that has greater than average susceptibility to thermal decay, much less manufacturing the disk so that magnetic media in a predetermined portion is thinner than average and identifying the sector based on the predetermined portion. Quak and Ishida say nothing about using a test pattern for a refresh operation or any other operation that involves user data or identifying a sector on the disk where the magnetic media is manufactured to be thinner than average at a predetermined portion. Thus, Quak and Ishida fail to cure this deficiency.

The Examiner admits that "Alex and Quak et al. does not further teach wherein making (i.e. manufacturing) a medium with different thickness in the film" and then asserts that "Ishida et al. does teach a disk that has been made or manufactured to have different thickness as shown in Fig. 2, Element 22."

Ishida fails to teach or suggest making the disk with different magnetic media thickness. Instead, the master information carrier which records servo signals, address signals and clock signals on the disk is made with ferromagnetic film with varying thickness.

The Examiner has failed to explain how Alex and Quak in view of Ishida teaches or suggests performing the refresh operation by identifying a sector where the magnetic media is manufactured to be thinner than average at a predetermined portion and then writing the user data to the sector in response to the identification.

Furthermore, Quak is not prior art to Claim 85.

<u>Claim 89 (Group III)</u>

Claim 89 distinguishes over Alex and Quak in view of Ishida for the reasons set forth above for Claim 86 and the Group I claim. Furthermore, Quak is not prior art to Claim 89.

<u>Claim 90 (Group IV)</u>

Claim 90 distinguishes over Alex and Quak in view of Ishida for the reasons set forth above for Claim 86 and the Group II claim. Furthermore, Quak is not prior art to Claim 90.

<u>Claim 94 (Group V)</u>

Claim 94 distinguishes over Alex and Quak in view of Ishida for the reasons set forth above for Claim 91 and the Group I claim. Furthermore, Quak is not prior art to Claim 94.

<u>Claim 95 (Group VI)</u>

Claim 95 distinguishes over Alex and Quak in view of Ishida for the reasons set forth above for Claim 91 and the Group II claim. Furthermore, Quak is not prior art to Claim 95.

6. Conclusion

In order to establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all of the claim limitations. (M.P.E.P. § 2143, Rev. 4, October 2005, page 2100-135).

If the proposed modification would render the prior art unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. (M.P.E.P. § 2143.01(V), Rev. 4, October 2005, page 2100-137).

The Examiner bears the initial burden of factually supporting any *prima facie* conclusion of obviousness. (M.P.E.P. § 2142, Rev. 4, October 2005, page 2100-133). In view of the above, Applicants believe that the Examiner has failed to meet this burden.

I am an attorney of record with respect to the above-identified application.

A representative from the U.S. Patent and Trademark Office is invited to contact the undersigned at the below-listed telephone number regarding any matters relating to the present application.

Respectfully submitted,

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VIII. Claims Appendix

1. A method for providing an early warning of thermal decay, comprising:

writing a test pattern to a track of a magnetic disk, wherein said test pattern has a higher data density than a data density of user data in said track;

measuring an amplitude of a signal produced by reading said test pattern;

storing said measured amplitude;

reading said test pattern from said track to obtain an observed amplitude of a signal produced by said test pattern;

comparing said measured amplitude to said observed amplitude; and

producing a thermal decay warning signal if said comparison is unfavorable.

2. The method of Claim 1, wherein said test pattern has a test frequency in said track that is higher than a nominal data frequency for user data in said track.

3. The method of Claim 2, wherein said track is located within a first zone of said magnetic disk, said test frequency is a nominal data frequency for user data in a second zone of said magnetic disk, and said first zone is located towards an inside diameter of said magnetic disk relative to said second zone.

4. The method of Claim 1, further comprising identifying a sector of said magnetic disk at which a magnetic medium of said magnetic disk is thinner than an

average thickness of said magnetic medium, and then writing said test pattern to said sector in response to said identification.

5. The method of Claim 4, further comprising identifying said sector by measuring the amplitude of signals produced by automatic gain control fields, wherein said identified sector is associated with one of said automatic gain control fields producing an amplitude that is less than a nominal amplitude for said automatic gain control fields.

6. The method of Claim 1, further comprising, in response to said thermal decay warning signal, refreshing data stored on said magnetic disk.

7. The method of Claim 1, wherein said test pattern is written to each data storage surface of each magnetic disk included in a hard disk drive.

8. The method of Claim 1, wherein said steps of reading said test pattern, comparing said measured amplitude, and producing said thermal decay warning signal are performed periodically.

9. The method of Claim 1, further comprising creating a predetermined portion of said magnetic disk having a greater than average susceptibility to thermal decay during manufacture of said magnetic disk, and then writing said test pattern to said

predetermined portion of said magnetic disk in response to identifying said predetermined portion of said magnetic disk.

10. The method of Claim 1, wherein said test pattern is written in accordance with a longitudinal recording scheme.

11. A method for providing an early warning of thermal decay, comprising:

writing a test pattern to a track of a magnetic disk, wherein said test pattern has a lower data density than a data density of user data in said track;

measuring an amplitude of a signal produced by reading said test pattern;

storing said measured amplitude;

reading said test pattern from said track to obtain an observed amplitude of a signal produced by said test pattern;

comparing said measured amplitude to said observed amplitude; and

producing a thermal decay warning signal if said comparison is unfavorable.

12. The method of Claim 11, wherein said test pattern has a test frequency in said track that is lower than a nominal data frequency for user data in said track.

13. The method of Claim 12, wherein said track is located within a first zone of said magnetic disk, said test frequency is a nominal data frequency for user data in a second zone of said magnetic disk, and said first zone is located towards an outside diameter of said magnetic disk relative to said second zone.

14. The method of Claim 11, further comprising identifying a sector of said magnetic disk at which a magnetic medium of said magnetic disk is thinner than an average thickness of said magnetic medium, and then writing said test pattern to said sector in response to said identification.

15. The method of Claim 14, further comprising identifying said sector by measuring the amplitude of signals produced by automatic gain control fields, wherein said identified sector is associated with one of said automatic gain control fields producing an amplitude that is less than a nominal amplitude of said automatic gain control fields.

16. The method of Claim 11, further comprising, in response to said thermal decay warning signal, refreshing data stored on at least a portion of said magnetic disk.

17. The method of Claim 11, wherein said test pattern is written to each data storage surface of each magnetic disk included in a hard disk drive.

18. The method of Claim 11, wherein said steps of reading said test pattern, comparing said measured amplitude, and producing said thermal decay warning signal are performed periodically.

19. The method of Claim 11, further comprising creating a predetermined portion of said magnetic disk having a greater than average susceptibility to thermal decay during manufacture of said magnetic disk, and then writing said test pattern to said predetermined portion of said magnetic disk in response to identifying said predetermined portion of said magnetic disk.

20. The method of Claim 11, wherein said test pattern is written in accordance with a perpendicular recording scheme.

21. A method for detecting thermal decay in a hard disk drive, comprising:

identifying a sector of a magnetic disk having a magnetization that is less than an average magnetization for said magnetic disk;

writing an early warning pattern to said sector;

reading an amplitude of said early warning pattern to obtain a reference amplitude;

storing said reference amplitude;

reading an amplitude of said early warning pattern to obtain an observed amplitude; and

producing a thermal decay warning signal if said observed amplitude is less than said reference amplitude by more than a predetermined amount.

22. The method of Claim 21, further comprising identifying said sector by observing an amplitude of a selected type of servo sector information written to said disk,

and then writing said early warning pattern to said sector in response to said identification, wherein said sector is associated with one of said selected type of servo sector information having an amplitude that is at least about 10% less than an average amplitude of said selected type of servo sector information.

23. The method of Claim 22, wherein said selected type of servo sector information comprises automatic gain control information.

24. The method of Claim 21, further comprising identifying said sector by identifying an area of said magnetic disk having a magnetic media thickness that is less than an average thickness of said magnetic media, and then writing said early warning pattern to said sector in response to said identification, wherein said sector is located in said area of said magnetic disk.

25. The method of Claim 21, further comprising producing a predetermined area of said magnetic disk having a magnetic media thickness that is less than an average thickness of said magnetic media, and then writing said early warning pattern to said sector in response to identifying said predetermined area of said magnetic disk, wherein said sector has a magnetization that is less than an average magnetization for said magnetic disk and is located within said predetermined area of said magnetic disk.

26. The method of Claim 25, wherein said hard disk drive stores data according to a longitudinal recording scheme, and said predetermined area of said magnetic disk is located towards an inner diameter of said magnetic disk.

27. The method of Claim 25, wherein said hard disk drive stores data according to a perpendicular recording scheme, and said predetermined area of said magnetic disk is located towards an outer diameter of said magnetic disk.

28. The method of Claim 21, wherein said hard disk drive stores data according to a longitudinal recording scheme, and said early warning pattern has a frequency in said sector greater than a nominal data frequency for user data stored on a track comprising said sector.

29. The method of Claim 21, wherein said hard disk drive stores data according to a perpendicular recording scheme, and said early warning pattern has a frequency in said sector less than a nominal data frequency for user data stored on a track comprising said sector.

30. A method of detecting thermal decay in a magnetic storage device, comprising:

writing a test pattern having a greater susceptibility to thermal decay than a 1T pattern to a magnetic storage medium;

reading an amplitude of a signal produced by said test pattern to obtain a reference amplitude;

storing said reference amplitude;

reading an amplitude of a signal produced by said test pattern to obtain an observed amplitude;

comparing said reference amplitude to said observed amplitude; and

in response to an unfavorable comparison, producing a thermal decay warning signal.

31. The method of Claim 30, further comprising:

writing a first evaluation test pattern to said magnetic storage medium;

writing a second evaluation test pattern to said magnetic storage medium; and

selecting said test pattern from said first and second evaluation test patterns.

32. The method of Claim 30, further comprising identifying a portion of said magnetic storage medium having a susceptibility to thermal decay that is greater than an average susceptibility to thermal decay of said magnetic storage medium, and then writing said test pattern to said portion of said magnetic storage medium in response to said identification.

33. The method of Claim 32, wherein said portion of said magnetic storage medium has a less than average magnetic storage material thickness.

34. The method of Claim 30, wherein said magnetic storage device stores data according to a longitudinal recording scheme.

35. The method of Claim 30, wherein said magnetic storage device stores data according to a perpendicular recording scheme.

36. A hard disk drive, comprising:

a base;

a magnetic storage disk comprising a magnetic storage material and data tracks;

a transducer head for reading and writing information to and from said data tracks, wherein said information comprises a test pattern, and said transducer head is movable in a radial direction with respect to said disk to address a selected one of said data tracks;

a voice coil motor for moving said transducer head with respect to said data tracks;

a controller, interconnected to said voice coil motor, for controlling a position of said transducer head with respect to said data tracks; and

a channel, interconnected to said transducer head, wherein an amplitude of a signal derived from said test pattern in a data track of said data tracks and having a greater susceptibility to thermal decay than user data in said data track is transmitted by said channel, and a thermal decay warning signal is generated if said amplitude of said warning signal is less than a reference amplitude.

37. The hard disk drive of Claim 36, wherein said test pattern is written to an area of said magnetic storage disk having a magnetic storage material thickness that is less than a prescribed amount in response to identifying said area of said magnetic storage disk.

38. The hard disk drive of Claim 37, wherein said prescribed amount has a thickness that is less than about 90% of an average thickness of said magnetic storage material.

39. The hard disk drive of Claim 37, wherein said magnetic storage disk is formed having a magnetic storage material thickness that is intentionally reduced in said area of said magnetic storage disk.

40. The hard disk drive of Claim 36, wherein said test pattern is written to an area of said magnetic storage disk having an increased probability that magnetic domains in said area will return to a direction occupied by said magnetic domains in response to identifying said area of said magnetic storage disk.

41. The hard disk drive of Claim 36, wherein said hard disk drive stores data using a longitudinal recording scheme, said data track is located in a first zone of said magnetic storage disk, said test pattern has a test frequency that corresponds to a data frequency for user data located in a second zone of said magnetic storage disk, and said

second zone is located farther from an interior diameter of said magnetic storage disk than is said first zone.

42. The hard disk drive of Claim 36, wherein said hard disk drive stores data using a perpendicular recording scheme, said data track is located in a first zone of said magnetic storage disk, said test pattern has a test frequency that corresponds to a data frequency for user data located in a second zone of said magnetic storage disk, and said second zone is located farther from an outside diameter of said magnetic storage disk than is said first zone.

43. The hard disk drive of Claim 36, wherein said hard disk drive stores data using a longitudinal recording scheme, and said test pattern has a test frequency in said data track that is greater than a nominal frequency of said user data in said data track.

44. The hard disk drive of Claim 36, wherein said hard disk drive stores data using a perpendicular recording scheme, and said test pattern has a test frequency in said data track that is less than a nominal frequency of said user data in said data track.

45. The hard disk drive of Claim 36, wherein said hard disk drive stores data using a perpendicular recording scheme, and said test pattern comprises a 12T pattern or greater.

46. The hard disk drive of Claim 36, wherein said hard disk drive stores data using a perpendicular recording scheme, and said test pattern comprises a 24T pattern or greater.

47. A hard disk drive, comprising:

a base;

a magnetic storage disk comprising a magnetic storage material and data tracks, wherein a data track of said data tracks has a reduced magnetization capacity;

a transducer head for reading and writing information to and from said data tracks, wherein said information comprises a test pattern, and said transducer head is movable in a radial direction with respect to said disk to address a selected one of said data tracks;

a voice coil motor for moving said transducer head with respect to said data tracks;

a controller, interconnected to said voice coil motor, for controlling a position of said transducer head with respect to said data tracks; and

a channel, interconnected to said transducer head, wherein an amplitude of a signal derived from said test pattern in said data track and having a different data density in said data track than user data in said data track is transmitted by said channel, and a thermal decay warning signal is generated if said amplitude of said warning signal is less than a reference amplitude.

48. The hard disk drive of Claim 47, wherein said reduced magnetization capacity of said data track corresponds to a reduced magnetic storage material thickness.

49. The hard disk drive of Claim 48, wherein an area of said magnetic storage disk comprising said data track and said reduced magnetic storage material thickness is formed at a predetermined location on said magnetic storage disk.

50. The hard disk drive of Claim 49, wherein said hard disk drive stores data according to a longitudinal recording scheme, and said predetermined location is towards an inside diameter of said magnetic storage disk.

51. The hard disk drive of Claim 49, wherein said hard disk drive stores data according to a perpendicular recording scheme, and said predetermined location is towards an outside diameter of said magnetic storage disk.

52. The hard disk drive of Claim 47, wherein said hard disk drive stores data according to a longitudinal recording scheme, and said test pattern has a higher frequency in said data track than a user data frequency in said data track.

53. The hard disk drive of Claim 47, wherein said hard disk drive stores data according to a perpendicular recording scheme, and said test pattern comprises a 12T or greater pattern.

54. The hard disk drive of Claim 47, wherein said hard disk drive stores data according to a perpendicular recording scheme, and said test pattern comprises a 24T or greater pattern.

55. The hard disk drive of Claim 47, wherein said hard disk drive stores data according to a perpendicular recording scheme, and said test pattern comprises a 12T pattern and a 24T pattern.

56. A hard disk drive, comprising:

a base;

a magnetic storage disk comprising a magnetic storage material and data tracks, wherein a data track of said data tracks has a reduced magnetization capacity;

a transducer head for reading and writing information to and from said data tracks, wherein said information comprises an early warning pattern, and said transducer head is movable in a radial direction with respect to said disk to address a selected one of said data tracks;

a voice coil motor for moving said transducer head with respect to said data tracks;

a controller, interconnected to said voice coil motor, for controlling a position of said transducer head with respect to said data tracks; and

a channel, interconnected to said transducer head, wherein an amplitude of a signal derived from said early warning pattern in said data track and having a greater susceptibility to thermal decay than a 1T pattern in said data track is transmitted by said

channel, and a thermal decay warning signal is generated if said amplitude of said warning signal is less than a reference amplitude.

57. The hard disk drive of Claim 56, wherein said early warning pattern is written to an area of said magnetic storage disk having a magnetic storage material thickness that is less than a prescribed amount in response to identifying said area of said magnetic storage disk.

58. The hard disk drive of Claim 57, wherein said hard disk drive identifies said area of said magnetic storage disk in response to reading servo information from said magnetic storage disk.

59. The hard disk drive of Claim 58, wherein said hard disk drive identifies said area of said magnetic storage disk at a factory before said hard disk drive is shipped to an end user.

60. The hard disk drive of Claim 58, wherein said servo information is automatic gain control information.

61. A method for providing an early warning of thermal decay in a disk drive, wherein the disk drive includes a magnetic disk, the disk includes a track, a test pattern on the track has a different data density than user data on the track, and the disk drive stores a reference amplitude, the method comprising:

reading the test pattern from the track to obtain an observed amplitude;

comparing the reference amplitude to the observed amplitude; and

producing a thermal decay warning signal if the comparison is unfavorable.

62. The method of Claim 61, wherein the test pattern is an early warning pattern that has greater susceptibility to thermal decay than any servo information and any user data on the disk.

63. The method of Claim 61, wherein the test pattern on the track has a higher susceptibility to thermal decay than user data on the track due to the different data density.

64. The method of Claim 61, wherein the test pattern on the track has a higher susceptibility to thermal decay than a 1T pattern on the track due to the test pattern on the track having a different data density than the 1T pattern on the track.

65. The method of Claim 61, wherein the disk includes first and second zones, the track is located in the first zone, and the test pattern has the same data density as user data in the second zone.

66. A method for providing an early warning of thermal decay in a disk drive, wherein the disk drive includes a magnetic disk, the disk includes a track, a test pattern

on the track has a larger data density than user data on the track, and the disk drive stores a reference amplitude, the method comprising:

reading the test pattern from the track to obtain an observed amplitude;

comparing the reference amplitude to the observed amplitude; and

producing a thermal decay warning signal if the comparison is unfavorable.

67. The method of Claim 66, wherein the test pattern is an early warning pattern that has greater susceptibility to thermal decay than any servo information and any user data on the disk.

68. The method of Claim 66, wherein the test pattern on the track has a higher susceptibility to thermal decay than user data on the track due to the larger data density.

69. The method of Claim 66, wherein the test pattern on the track has a higher susceptibility to thermal decay than a 1T pattern on the track due to the test pattern on the track having a larger data density than the 1T pattern on the track.

70. The method of Claim 66, wherein the disk includes first and second zones, the track is located in the first zone, and the test pattern has the same data density as user data in the second zone.

71. A method for providing an early warning of thermal decay in a disk drive, wherein the disk drive includes a magnetic disk, the disk includes a track, a test pattern

on the track has a smaller data density than user data on the track, and the disk drive stores a reference amplitude, the method comprising:

reading the test pattern from the track to obtain an observed amplitude;

comparing the reference amplitude to the observed amplitude; and

producing a thermal decay warning signal if the comparison is unfavorable.

72. The method of Claim 71, wherein the test pattern is an early warning pattern that has greater susceptibility to thermal decay than any servo information and any user data on the disk.

73. The method of Claim 71, wherein the test pattern on the track has a higher susceptibility to thermal decay than user data on the track due to the smaller data density.

74. The method of Claim 71, wherein the test pattern on the track has a higher susceptibility to thermal decay than a 1T pattern on the track due to the test pattern on the track having a smaller data density than the 1T pattern on the track.

75. The method of Claim 71, wherein the disk includes first and second zones, the track is located in the first zone, and the test pattern has the same data density as user data in the second zone.

76. A method for providing an early warning of thermal decay in a disk drive, wherein the disk drive includes a magnetic disk, the disk includes a track, a test pattern

on the track has a different data density than a 1T pattern on the track, and the disk drive stores a reference amplitude, the method comprising:

reading the test pattern from the track to obtain an observed amplitude;

comparing the reference amplitude to the observed amplitude; and

producing a thermal decay warning signal if the comparison is unfavorable.

77. The method of Claim 76, wherein the test pattern is an early warning pattern that has greater susceptibility to thermal decay than any servo information and any user data on the disk.

78. The method of Claim 76, wherein the test pattern on the track has a higher susceptibility to thermal decay than the 1T pattern on the track due to the different data density.

79. The method of Claim 78, wherein the test pattern on the track has a larger data density than the 1T pattern on the track.

80. The method of Claim 78, wherein the test pattern on the track has a smaller data density than the 1T pattern on the track.

81. A method for providing an early warning of thermal decay in a disk drive, wherein the disk drive includes a magnetic disk, the method comprising the following steps in the sequence set forth:

identifying a sector on the disk that has a greater than average susceptibility to thermal decay;

writing a test pattern to the sector in response to identifying the sector;

reading the test pattern from the sector to obtain a reference amplitude;

storing the reference amplitude in the disk drive;

reading the test pattern from the sector to obtain a measured amplitude;

comparing the reference amplitude and the measured amplitude; and

producing a thermal decay warning signal if the comparison is unfavorable.

82. The method of Claim 81, wherein identifying the sector includes:

reading servo information from the disk to obtain measured servo amplitudes; and

determining a portion of the disk that has a greater than average susceptibility to thermal decay based on the measured servo amplitudes, wherein the sector is associated with the portion of the disk.

83. The method of Claim 82, wherein the servo information is automatic gain control information.

84. The method of Claim 81, wherein identifying the sector includes determining a portion of the disk in which magnetic media of the disk is thinner than an average thickness of the magnetic media of the disk, and the sector is associated with the portion of the disk.

85. The method of Claim 81, wherein identifying the sector includes manufacturing the disk so that magnetic media in a predetermined portion of the disk is thinner than an average thickness of the magnetic media in the disk, and the sector is associated with the predetermined portion of the disk.

86. A method for providing an early warning of thermal decay in a disk drive, wherein the disk drive includes a magnetic disk, the method comprising the following steps in the sequence set forth:

identifying a sector on the disk that has a greater than average susceptibility to thermal decay;

writing a test pattern to the sector in response to identifying the sector, wherein the test pattern has a greater susceptibility to thermal decay than any servo information and any user data on the disk;

reading the test pattern from the sector to obtain a reference amplitude;

storing the reference amplitude in the disk drive;

reading the test pattern from the sector to obtain a measured amplitude;

comparing the reference amplitude and the measured amplitude; and

producing a thermal decay warning signal if the comparison is unfavorable.

87. The method of Claim 86, wherein identifying the sector includes:

reading servo information from the disk to obtain measured servo amplitudes; and

determining a portion of the disk that has a greater than average susceptibility to thermal decay based on the measured servo amplitudes, wherein the sector is associated with the portion of the disk.

88. The method of Claim 87, wherein the servo information is automatic gain control information.

89. The method of Claim 86, wherein identifying the sector includes determining a portion of the disk in which magnetic media of the disk is thinner than an average thickness of the magnetic media of the disk, and the sector is associated with the portion of the disk.

90. The method of Claim 86, wherein identifying the sector includes manufacturing the disk so that magnetic media in a predetermined portion of the disk is thinner than an average thickness of the magnetic media in the disk, and the sector is associated with the predetermined portion of the disk.

91. A method for providing an early warning of thermal decay in a disk drive, wherein the disk drive includes a magnetic disk, the method comprising the following steps in the sequence set forth:

identifying a sector on the disk that has a greater than average susceptibility to thermal decay;

writing a test pattern to the sector in response to identifying the sector;

reading the test pattern from the sector to obtain a reference amplitude;

storing the reference amplitude in the disk drive;

shipping the disk drive from a factory to an end user;

reading the test pattern from the sector to obtain a measured amplitude;

comparing the reference amplitude and the measured amplitude; and

producing a thermal decay warning signal if the comparison is unfavorable.

92. The method of Claim 91, wherein identifying the sector includes:

reading servo information from the disk to obtain measured servo amplitudes; and

determining a portion of the disk that has a greater than average susceptibility to thermal decay based on the measured servo amplitudes, wherein the sector is associated with the portion of the disk.

93. The method of Claim 92, wherein the servo information is automatic gain control information.

94. The method of Claim 91, wherein identifying the sector includes determining a portion of the disk in which magnetic media of the disk is thinner than an average thickness of the magnetic media of the disk, and the sector is associated with the portion of the disk.

95. The method of Claim 91, wherein identifying the sector includes manufacturing the disk so that magnetic media in a predetermined portion of the disk is

thinner than an average thickness of the magnetic media in the disk, and the sector is associated with the predetermined portion of the disk.

96. A method for providing an early warning of thermal decay in a disk drive, wherein the disk drive includes a magnetic disk, the method comprising the following steps in the sequence set forth:

writing evaluation test patterns to the disk;

reading the evaluation test patterns from the disk;

selecting a test pattern from the evaluation test patterns that exhibits the greatest amount of thermal decay;

writing the test pattern to a sector on the disk;

reading the test pattern from the sector to obtain a reference amplitude;

storing the reference amplitude in the disk drive;

reading the test pattern from the sector to obtain a measured amplitude;

comparing the reference amplitude and the measured amplitude; and

producing a thermal decay warning signal if the comparison is unfavorable.

97. The method of Claim 96, including subjecting the disk to elevated temperature between writing and reading the evaluation test patterns.

98. The method of Claim 96, wherein the test pattern has a greater susceptibility to thermal decay than any servo information and any user data on the disk.

99. The method of Claim 98, wherein the test pattern on a track of the disk has a larger data density than a 1T pattern on the track.

100. The method of Claim 98, wherein the test pattern on a track of the disk has a smaller data density than a 1T pattern on the track.

IX. <u>Evidence Appendix</u>

The evidence appendix contains the provisional reproduced with inserted page and line numbers, which was entered as Exhibit A in the Reply dated April 26, 2006.

I Introduction

Thermal decay is becoming an increasing concern to the stability of magnetic storage devices. The phenomena are generally associated with the decay of amplitude of a recorded transition over time. The physics of the decay is governed by the ratio of the energy barrier for magnetization switching (KuV) to the thermal energy of the surrounding environment (kT).

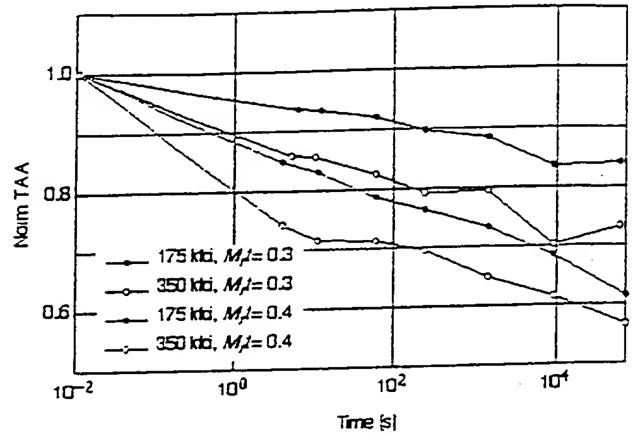
The energy barrier is a complicated function of the properties of the magnetic material and the magnetic field in the magnetic material. More specifically, properties such as anisotropy constant, grain size, demagnetization field and their distribution are the key factors in governing the thermal decay. In general, for a given magnetic material, the thermal decay rate increases with the increasing demagnetization field. The demag field is proportional to the magnetization of the material (Mrt). In addition, the demag field also increases with transition density, i.e., the closer the transitions are, the stronger the demag field in the transitions is.

Proposed monitoring of thermal decay in a storage device

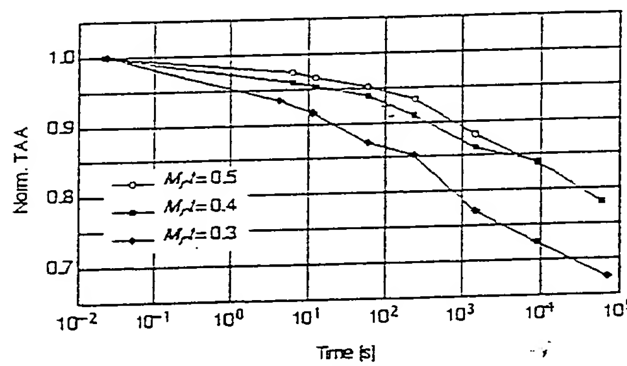
The proposed thermal decay EARLY Warning procedure is based on the above stated physical principle. A pattern that decays faster than the signal the device uses for storage, hereafter referred to as Warning Pattern (WP), will be utilized to provide the monitoring. The Warning Pattern will be written in prior to shipping out of factory. Certain aspects of the Warning Pattern, such as amplitude, will be measured and stored for later reference. The WP will be read periodically and the measured values of the reference parameters will be compared with the originally stored values. A threshold for the difference will be established by the design engineer and preset into the device to provide action control. If the change in the WP is larger than the predetermined threshold, pre-determined actions will be taken. Such actions may include data refresh, warning to users, etc.

The Key to EARLY Warning lies in the design and construction of the WP and the locations (in the storage media) of the WP. The principle in choosing these parameters is such that the decay of the WP is FASTER than any other pattern used in the device for conventional storage purpose, such as data pattern and servo pattern. Two possible suggestions for constructing the WP are listed below:

1) Choose a frequency (transition density) higher than the highest data pattern in the device. As an example, this can be achieved in a disk drive by writing a 1T frequency of an OD zone in an ID zone. The effective transition density will be much higher than the 1T pattern of that ID zone. The WP will therefore decay considerably earlier than any pattern used for data and servo for this particular drive design. Hence, detecting the decay of the WP pattern offers early warning of the drive's thermal decay. Alternatively, we can also use the internal diagnostic parameters associated with WP, such as VGA register value, as an indicator for the decay. For example, VGA register value is when the head is reading the WP pattern is recorded and stored in the drive prior to factory exit and in the filed, the same VGA register is read (defined by firmware) periodically. The reading results are compared to that of the factory stored value to determine the amount of thermal decay over time.



2) Measure the servo AGC field for the ID zone. Pick a sector that follows the lowest amplitude. This sector will thus have the lowest Mrt of the disk. Write a 1T pattern on this sector only and use the 1T pattern on this sector as the WP. Since this sector has the lowest Mrt of the zone (can be around 10% lower than nominal), and this zone has the highest nominal transition density, the thermal decay of the WP will serve as EARLY warning for the entire surface.



Numerous other approaches to establish a WP exist that serve the desired purpose, such as patterns with different 01 sequence, different frequency, PW50, resolution (defined in multiple ways) etc.

Key claims of the disclosure will be:

1) Writing a specific pattern to serve as a thermal decay Warning Pattern
2) WP is more stressful thermal wise and the decay of this signal provides an early warning for the entire system.
3) Some easy ways of constructing the WP, as exemplified above.

Warning of system level failure due to this mechanism BEFORE failure actually occur therefor allow recovery procedures to be invoked prior to any damage. The lead time of the warning signal can be adjusted by different construction of the Warning Pattern, as described in the body of the disclosure.

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X. Related Proceedings Appendix

None